Collins

51R-3
NAVIGATION RECEIVER

INSTRUCTION BOOK

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Cedar Rapids, Iowa

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Instruction Book

for

51R-3 VHF
Navigation Receiver

COLLINS

COLLINS RADIO COMPANY
Cedar Rapids, Iowa

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Second Edition
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Printed in the United States of America

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(C) Item or symbol number obtained from parts list or schematic
(D) Collins' type number, name, and serial number of principal equipment
(E) Unit sub-assembly number (where applicable)

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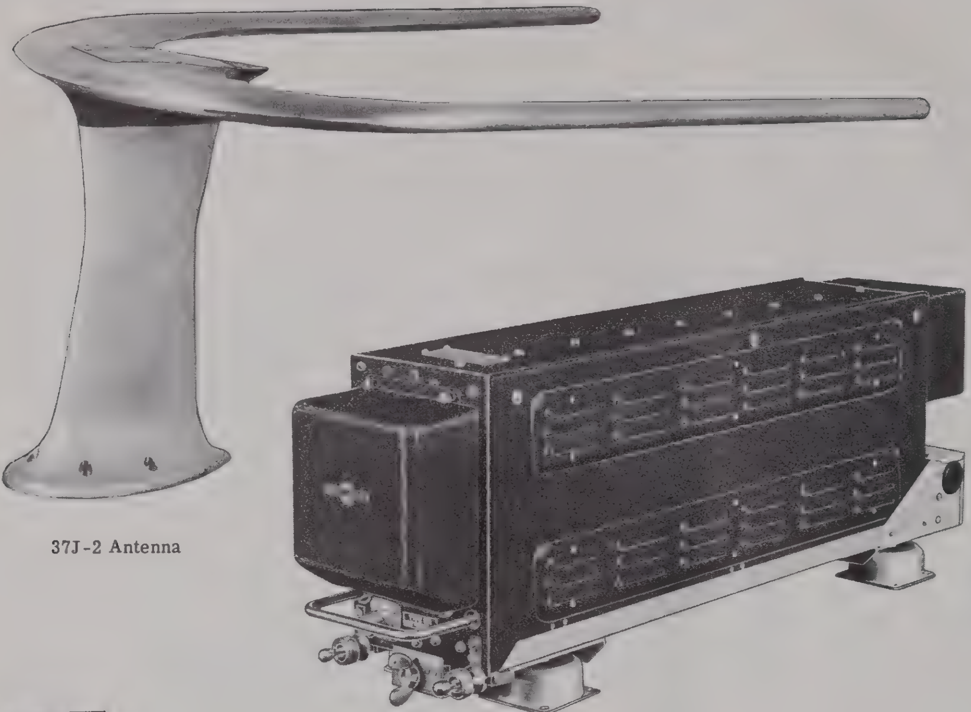
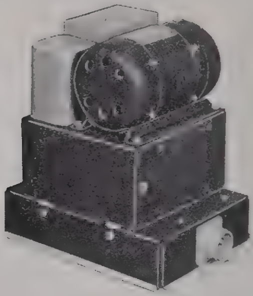
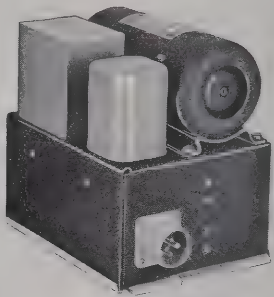


37J-2 Antenna

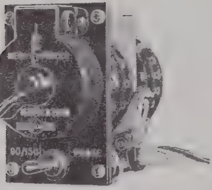
51R-3 Receiver



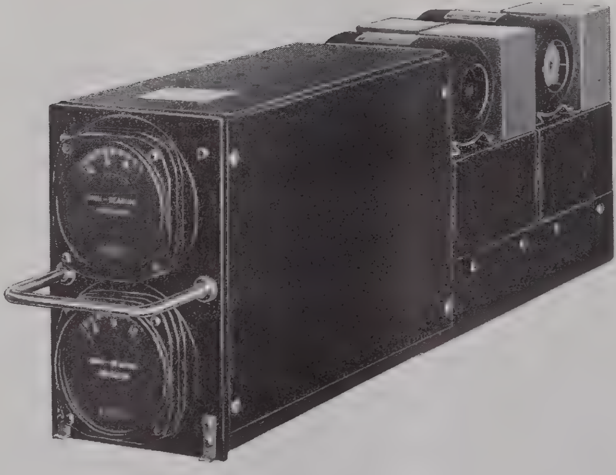
416N-1 Power Unit



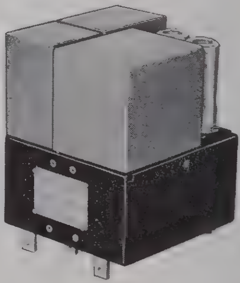
416N-2 Power Unit



314U-5 Control Unit

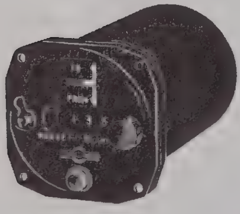


351A-1 Accessory Frame

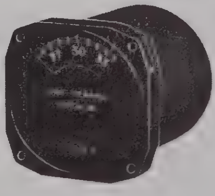


416N-5 Power Unit

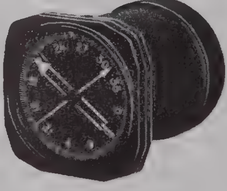
ID-48 Deviation Indicator



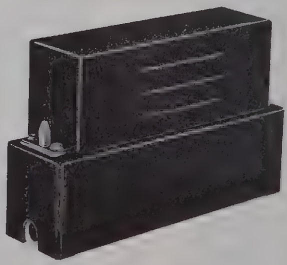
336A-2 Omni Bearing Selector



337A-2
Omni Bearing Indicator



332C-1
Radio Magnetic Indicator



333B-3 Servo Amplifier

Figure 1-1. Collins Type 51R-3 VHF Navigation Receiver and Accessories.

SECTION 1

GENERAL DESCRIPTION

1-1. PURPOSE OF EQUIPMENT.

The Collins Type 51R-3 Navigation Receiver and accessories are designed to fulfill the 108 to 136 mc band navigation and communication receiving requirements of all types of military, commercial and private aircraft. Instrumentation circuits are provided in the receiver and accessories for reception and presentation of all radio services available in this portion of the vhf spectrum. These facilities include:

a. Selection of frequency on Type 314U Frequency Control Unit.

b. Selection of omni-bearing line on the Type 336A-2 Omni-Bearing Selector.

c. Indications of deviation from omni-bearing line on Type ID-48 Deviation Indicator.

d. Indication of magnetic bearing of the omni-range on Type 332C-1 Radio Magnetic Indicator.

e. Indication of magnetic heading of the aircraft on Type 332C-1 Radio Magnetic Indicator.

f. Indication of magnetic bearing of the omni-range on Type 337A-2 Omni-Bearing Indicator.

g. Reception of localizer facilities with course deviation indications on Type ID-48 Deviation Indicator.

h. Omni-bearing line sensing on TO-FROM portion of 336A-2 Omni-Bearing Selector.

i. Flag alarm indications on ID-48 Deviation Indicator to indicate lack of satisfactory signal levels on localizer or omni-range facilities.

j. Reception of voice facilities on communication channels or superimposed on navigation signals in localizer and omni-range bands.

1-2. LIST OF EQUIPMENT.

All of the equipment associated directly with the 51R-3 receiver is listed below.

TABLE 1-1

Type	Name	Weight lbs.	Collins Part No.
51R-3	Receiver	29.5	505 4067 005
37J-2 or 37J-3	Antenna	5.75	505 6800 004
Single	Shockmount	2.6	See TABLE 2-1
Dual	Shockmount	4.7	See TABLE 2-1
ID-48	Deviation Indicator	1.87	458 0126 00
336A-2	Omni-Bearing Selector	1.9	504 2568 005
337A-2	Omni-Bearing Indicator	1.5	504 3191 004
332C-1	Radio Magnetic Indicator	2.5	482 0001 00
333B-1	Servo Amplifier	2.0	520 3724 00
333B-3	Servo Amplifier	3.3	520 3723 00
314U-1	Control Unit	.8	520 3721 00
314U-2	Control Unit	.8	503 7991 004
314U-5	Control Unit	.8	504 4232 004
314U-8	Control Unit	.8	596 1955 004
416N-1	Power Supply	9.4	520 3720 00
416N-2	Power Supply	10.7	520 4090 00
416N-4	Power Supply	7.5	505 3705 003
416N-5	Power Supply	8.2	505 3706 003
351A-1	Accessory Frame	7.3	505 5540 004

The major components of a typical maximum instrumentation system are listed below:

TABLE 1-2

Type	Name	Weight lbs.	Collins Part No.
51R-3	Receiver	29.5	505 4067 005
	Double Shockmount	4.7	See TABLE 2-1
314U-8	Control Unit	.8	596 1955 004
37J-2 or 37J-3	Antenna	5.75	505 6800 004
ID-48A	Deviation Indicator	1.87	458 0126 00
416N-5	Power Supply	8.2	505 3706 003
336A-2	Omni-Bearing Selector	1.9	504 2568 005
337A-2	Omni-Bearing Indicator	1.5	504 3191 004
332C-1	Radio Magnetic Indicator	2.5	482 0001 00
333B-1	Servo Amplifier	2.0	520 3724 00
351A-1	Accessory Frame	7.3	505 5540 004
37P-1 or 37P-3	Glide Slope Antenna	1.25	522 0027 003

1-3. PRINCIPLE OF OPERATION.

Signals from the vhf omni-range are received on the 37J-2 antenna and fed through coaxial cable to the 51R-3 receiver. The receiver employs a double conversion crystal controlled superheterodyne circuit to convert the received signal to a relatively low frequency for demodulation. Remote frequency selection, by channel, is accomplished from the 314U Frequency Control Unit by the use of an Autopositioner rotary positioning system. The signals recovered from the r-f carrier at the detector are as follows:

a. A 30 cps variable phase signal.

b. A 9960 cps subcarrier frequency modulated by a 30 cps reference phase signal with a deviation ratio of 16.

c. A composite 90 and 150 cps signal. (localizer only).

d. An audio signal (voice or station identification code).

The phase of the 30 cps variable phase signal, a. above, varies as the omni-bearing. The phase of the 30 cps reference phase signal is fixed and the same for all omni-bearings as well as all omni-ranges. In the 51R-3 receiver the phase of the 30 cps variable phase signal, a. above, is compared with the phase of the 30 cps reference phase signal recovered from the subcarrier, b. above, and the resulting phase difference information is used to operate the vertical needle of the ID-48 Deviation Indicator. The Type 337A Omni-Bearing Indicator is part of a servo system following a similar phase comparison system that provides a continuous indication of omni-bearing. During localizer operation the composite 90 and 150 cps signal, c. above, is separated into its two components by the use of a 90 cps band pass filter and a 150 cps band pass filter. The relative amplitudes of these two signals are rectified and compared, and the resulting difference current is used to operate the vertical needle of the ID-48 Deviation Indicator. The portion of the demodulated signal which contains voice or station identification code is fed through an aural channel consisting of a noise limiter, squelch circuit and audio amplifiers. The output amplifier is connected to the aircraft's interphone system.

1-4. FREQUENCY COVERAGE AND ALLOCATION.

The receiver may be remotely tuned on the 314U Frequency Control Unit to any one of 280 channels spaced at 100 kc intervals from 108.0 through 135.9 megacycles. Present assignments in this band are as follows:

Frequencies	Use
108.0 - 111.9 mc	Localizer
112.0 - 117.9 mc	Omni-Range
118.0 - 121.9 mc	Tower (voice)
122.0 - 135.9 mc	Communications

Three different types of reception are indicated in these allocations. They are localizer, omni-range, and voice. In addition to tuning the receiver to the desired channel, the 314U Frequency Control Unit switches the receiver circuits to perform the required functions for each type of reception. The receiver, as it leaves the factory, is wired to correspond to the frequency assignments shown above or the assignments existing

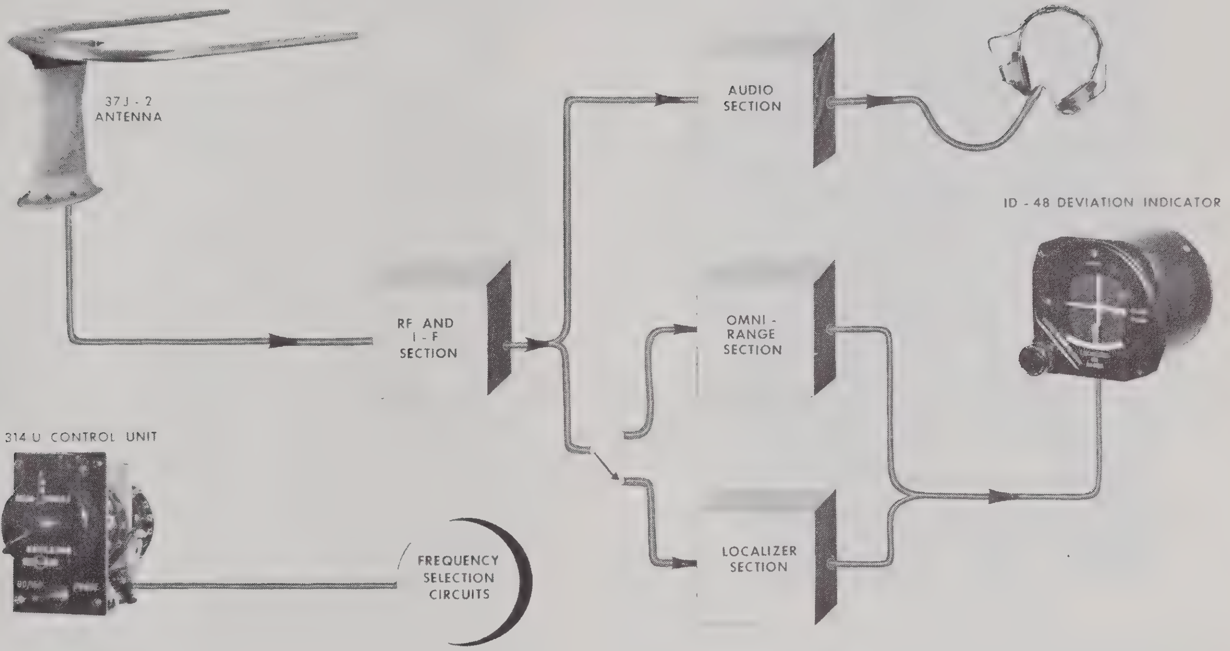


Figure 1-2. Simplified Block Diagram of 51R-3 Receiver

at the time of delivery. If these assignments are changed after the receiver leaves the factory, the receiver switching may be changed to agree with the new frequency assignments by simple jumpering procedures on a terminal board provided for this purpose. This terminal board is located on the front panel and is accessible upon removal of the front dust cover. See detailed procedure in Section 8, Maintenance.

1-5. DESCRIPTION OF PRINCIPAL COMPONENTS.

a. TYPE 51R-3 RECEIVER. The Type 51R-3 Receiver performs the functions of receiving and detecting the transmitted r-f signal, setting up the receiving frequency, and changing the composite detected signal into the signals necessary to operate the navigation instrumentation. The receiver is contained in a case of 1/2 ATR (JAN A-1-d) size. An antenna input connector located in the lower left corner of the front panel connects RG-8/U coaxial cable from the 37J-2 antenna to the receiver. All other external connections to the receiver are made through a plug on the rear of the shockmount. The receiver plugs into its shockmount and is secured by tightening two knurled nuts on the front of the shockmount. An extractor, accessible at the front of the shockmount, enables easy separation of the receiver from its shockmount. A handle is provided on the front panel of the receiver to aid in removing and handling. The 51R-3 receiver is interchangeable with the Type 51R-1 and 51R-2 receivers.

b. TYPE 314U-5, FREQUENCY CONTROL UNIT. The 314U-5 Frequency Control Unit provides for remote selection of any one of 280 frequency channels in the range 108.0 through 135.9 megacycles. Two concentric knobs are used to set the desired frequency into the vertical window. The large outer knob is used to select whole number megacycle positions, the small inner knob tenth megacycle positions. Vertically downward in the window, the numbers represent hundreds, tens, units and tenths of megacycles. Two lamps, replaceable from the front panel, illuminate the vertical window. The Type 314U-2 is designed for horizontal mounting with numerals reading from left to right.

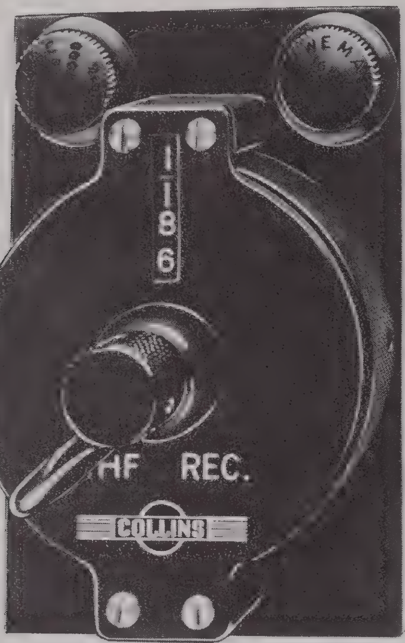


Figure 1-3. Type 314U-8 Control Unit

c. TYPE 314U-8 FREQUENCY CONTROL UNIT (See figure 1-3). The 314U-8 Control Unit is similar in function to the 314U-5 model except that it has, in addition, provision for volume control of the interphone amplifier through a knob concentric with the channel selection knobs. The 314U-8 Control Unit is designed for 100 kc channel spacing. A modification kit will allow changing to 50 kc channel spacing. The panel is edge lighted. When the control is mounted on a Lucite edge lighted panel, the light is picked up by a pedestal, which has reflecting surfaces behind it, and brought to the rear of the Lucite knob. When the switch is mounted on a metal panel, a small Lucite insert leads the light from the lamps to the pedestal and thence to the rear of the knob.

d. ID-48A DEVIATION INDICATOR. Course deviation is indicated on the vertical pointer of this Weston Model 888 instrument. The horizontal pointer is connected to a glide slope receiver. The airplane is flown in a direction toward the pointers to maintain the flight path. Both the vertical and horizontal pointers are actuated by 150-0-150 microammeter movements. Two flag alarms labeled OFF come into view at the bottom end of the vertical pointer and the right end of the horizontal pointer whenever signal levels decrease to the extent that the indication of the associated pointer is unreliable. A marker beacon lamp is located on the lower left side of the instrument. It is operated by a marker beacon receiver. Operation of the lamp may be tested by depressing its housing.

e. TYPE 37J-2 ANTENNA. The 37J-2 Antenna is a deerhorn type antenna designed to receive horizontally polarized waves from 108 to 122 megacycles. It is connected to the receiver at its base by a 52 ohm coaxial cable, RG-8/U or equivalent, and has provision for mating with a UG-21/U or equivalent connector. A standing wave ratio of 5/1 or better is obtained over the frequency range 108-122 megacycles. The antenna is constructed of cast aluminum, tubular alloy and natural rubber. It mounts interchangeably with Antenna AS-27/ARN. (Also read paragraph l below)

f. TYPE 336A-2 OMNI-BEARING SELECTOR. This standard 3 inch panel instrument contains the mechanism and circuitry for omni-bearing selection and bearing sensing (TO-FROM indications). The desired omni-bearing is set on the counter type dial with a knob on the right. This knob is linked to a resolver in the case which shifts the phase of the omni-range reference phase voltage. A switch on the left actuates a shutter to reverse the MAGNETIC BEARING indication 180 degrees and reverse the TO-FROM indication.

g. TYPE 416N POWER SUPPLY. The Type 416N-1 and 416N-2 Power Supplies are dynamotor types supplying 250 volts dc from the aircrafts low voltage dc source. The 416N-1 Power Supply operates on 28 volts dc and the 416N-2 on 14 volts dc although the 416N-2 may be connected to operate on 28 volts also. The Type 416N-4 and 416N-5 are transformer-rectifier types and supply 250 volts dc from the aircrafts 115 volt 380-1000 cps source. The 416N-1 Power Supply is converted to a 416N-4 type by replacing the dynamotor with a Collins Type 399A-1 Rectifier Unit and making four wiring changes. See figure 12-18. The Types 416N-1, 416N-4 and 416N-5 may be mounted on Type 351A Accessory Frame or on mounting base #503 6643 003. The 416N-2 is not adapted to mounting on the 351A Accessory Frame.

NOTE

The equipment described above in a, b, c, d, e, f and g constitute that necessary for minimum instrumentation. For full instrumentation the components described in paragraphs h, i, and j below are required and the one described in k adds to the convenience of the installation.

h. TYPE 336A-2 OMNI-BEARING INDICATOR. The 337A-2 Omni-Bearing Indicator gives automatic omni-bearing indications and combines omni-bearing information with heading information for presentation on Type 332C-1 Radio Magnetic Indicator. An index at the top of the instrument indicates the magnetic bearing of the VHF omni-range on a rotating circular scale. The scale is calibrated to 360 degrees in 2 degree increments. The case contains a two phase servo motor driving a resolver and a differential generator. The resolver acts as a phase shifter in the automatic omni-bearing determining circuit. The differential generator adds heading and omni-bearing for operation of the double barred pointer synchro motor in the 332C-1 Radio Magnetic Indicator. Up to two OBI instruments may be mounted in the front panel of the Type 351A-1 Accessory Unit.

i. TYPE 332C-1 RADIO MAGNETIC INDICATOR. The Radio Magnetic Indicator consists of an azimuth card which rotates to indicate aircraft heading, and two pointers, one of which rotates to indicate the omni-bearing on the azimuth scale. The function of the other pointer depends upon the particular installation. It may be connected to low frequency ADF radio compass equipment or to another VHF navigation receiver. The rear of the instrument contains a double barred pointer synchro motor, a single barred pointer synchro motor, an azimuth card synchro control transformer and a two phase motor to drive the azimuth card.

j. TYPE 333B SERVO AMPLIFIER. This amplifier, together with the azimuth card control transformer and two phase motor in the RMI, forms a servo system that positions the RMI azimuth card according to signals received from the gyro stabilized magnetic compass. It is a one tube plug-in amplifier driving the two phase motor from the aircraft's 26 volt 400 cps source. The 333B-1 Servo Amplifier is designed for mounting on the 351A-1 Accessory Unit while the type 333B-3 is provided with a base for individual mounting.

k. TYPE 351A-1 ACCESSORY FRAME. The Type 351A-1 Accessory Frame is a frame of 1/2 ATR (JAN A-1-d) size which provides a convenient mounting arrangement for 51R accessories. It is designed to mount two Type 337A Omni-Bearing Indicators on the front panel, up to three Type 333B-1 Servo Amplifiers in the mid-section, and one or two Type 416N Power Supplies in the rear. All wiring for interconnection of these components is built-in. All external connections to these components are made through a plug in the rear. The unit mounts on and plugs into a shockmount similar to the one used for the Type 51R-3 Navigation Receiver. An extractor to ease separation of accessory unit from shockmount and two knurled securing nuts are accessible at the front. A handle is provided on the front panel to aid in removing and handling the unit.

l. DIFFERENCES BETWEEN ANTENNA TYPES.

(1) TYPE 37J-3 ANTENNA

The 37J-3 Antenna differs from the 37J-2 in the following ways.

A grounding strap from the dipole to the top of the mast has been added. Modification kits are available for conversion of the 37J-2 Antenna.

The tuning of the 37J-3 is fixed at the factory. No adjustment of this antenna after receipt by the customer is required.

(2) TYPE 37P-3 ANTENNA

The 37P-3 Antenna is identical to the 37P-1 with the exception of the length of the antenna from mounting base to extreme tip, which has been lengthened from 5-1/2 inches to 6-1/8. Dimensions of the 37P-1 are shown in figure 12-39 of this Instruction Manual.

1-6. TECHNICAL DATA.

a. SENSITIVITY: On omni-range signals full flag down indication occurs with less than 5 uv r-f input. Stable course indications are obtainable down to as low as 3 uv r-f input. For communications 3 uv r-f input, modulated 30 or 100% (dependent upon frequency) at 1000 cps, will produce at least 200 mw audio output at a signal-to-noise ratio of 6.0 db or greater.

b. SELECTIVITY OVERALL: Total bandwidth of the receiver at 6.0 db down is greater than 45 kc, and is less than 160 kc at 60.0 db down.

c. STABILITY: The receiver stability is well within 0.01% under all service conditions.

d. AUTOMATIC VOLUME CONTROL. Flat within 4 db total variation from 10 uv to 50,000 uv input. Very stable indications and constant deflection sensitivity are provided all the way from maximum range to very near the transmitter.

e. AUDIO OUTPUT: Single channel, 300 milliwatts to a 500 ohm circuit.

f. AUDIO FIDELITY: Within 6.0 db, 300 to 3500 cps.

g. NOISE LIMITER: A series diode peak clipping type limiter is provided in the receiver.

h. SQUELCH CIRCUIT: A carrier operated squelch circuit with an adjustable threshold is provided.

i. PARALLEL OPERATION: Simultaneous parallel operation of receivers on a common navigation-communications antenna such as the 37J (108-122 mc) is accomplished without interference.

j. UNDESIRED FREQUENCY REJECTION. Increased input selectivity and different local oscillator frequencies have reduced all responses to undesirable frequencies, including adjacent channel and image, to at least 80 db.

k. UNDESIRED FREQUENCY EMISSION: Increased shielding and filtering allow this receiver to meet the following requirements with regard to radiated interference and conducted noise:

	Frequency Band Megacycles	Shall not Exceed Microvolts
Radiated interference:	0.15 to 150	20
Conducted noise:	0.3 to 20	50

This specification allows no greater than 50 microvolts from 0.3 to 20 mc. with regard to conducted noise.

l. ACCURACY OF INDICATING CIRCUITS: On manual operation the indicated bearing will agree within ±1/2° of the mean bearing while for automatic indication an accuracy of ±1° is maintained.

m. TEMPERATURE: Exceeds the requirements as set forth in CAA Manual CM-16. The following limits are met when this receiver is subjected to temperatures in the range -55°C to +75°C.

(1) Localizer: On Course ±10 ua.
(2) VOR Manual: On Course ±3°.
(3) VOR Automatic: On Course ±3.5°.

n. HUMIDITY: Meets the requirements as set forth in CAA Manual CM-16.

o. ALTITUDE: Negligible effect on performance is observed with operation in the range from 0 to 50,000 feet.

p. VIBRATION: Vibration of the receiver, mounted on proper shockmount, for 90 minutes in each of three planes at an amplitude of .06 inch total excursion over the frequency range 10-55 cycles will impose course shifts no greater than +3 ua on Localizer, ±1° on VOR Manual, or ±1.5° on VOR Automatic operation.

q. MODULATION FREQUENCIES: A simultaneous change in the modulation frequency of 1.5% will impose course shifts no greater than ±5 ua on Localizer or ±1.5° on VOR Manual and Automatic operation.

r. MODULATION VOLTAGE: Variation of either or both VOR modulation voltages by ±25% from nominal in amplitude will impose course shifts no greater than ±0.5° on VOR Manual or ±1° on VOR Automatic operation. Variation of both 90/150 cycle voltages simultaneously ±25% from nominal in amplitude will impose a course shift of no greater than ±5 ua on Localizer operation.

s. UNDESIRED MODULATIONS: Special precautions have been taken to protect the receiver indicating circuits against unwanted or spurious modulations on the omni or localizer signals. Amplitude modulation of the 9960 cps subcarrier as high as 50% can be tolerated with negligible effect on the accuracy and stability of the indicating circuits.

t. RF INPUT LEVEL: Variation of receiver input from 10 to 50,000 microvolts will impose course shifts no greater than ±4 ua on Localizer or ±1/2° on VOR Manual and ±1° on VOR Automatic operation.

u. TUBE INTERCHANGE: Interchange of all tubes except V-124 and V-126, with other sets of tubes whose characteristics fall within the applicable tube specifications will impose course shifts no greater than the following, assuming no service controls are re-set. Localizer ±5 ua, VOR Manual ±0.5° and VOR Automatic ±1°.

v. A+ INPUT LEVEL: Variation of A+ voltage input level ±10% (26.5 V nominal) will impose course shifts no greater than ±3 ua on Localizer or ±1/2° on VOR Manual and ±1° on VOR Automatic operation.

w. RIPPLE ON A+: Introduction of 1 volt of ripple on the A+ input supply at any frequency will impose course shifts of no greater than ±8 ua on Localizer or ±1° on VOR Manual and ±2° on VOR Automatic operation.

x. POWER REQUIREMENTS*

With d-c Power Supply:

Operation	26.5 v at 4.7 amp
Autopositioner cycling	26.5 v at 6.8 amp

With a-c Power Supply:

Operation	26.5 v at 2 amp 115 v, 400 at 0.5 amp
Autopositioner cycling	26.5 v at 4.1 amp 115 v, 400 at 0.5 amp

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* Exclusive of 400 ~ (380 to 1000) power for instruments.

1-7. NEW PRODUCTS.

a. 314U-10 FREQUENCY CONTROL UNIT.

The 314U-10 Frequency Control Unit provides frequency selection facilities for one navigation receiver and one glide slope receiver. The unit is similar in appearance to other members of the 314U series of control units. Figures 12-11 and 12-36 at the back of this book present the important characteristics of this unit.

b. 614F-2 FREQUENCY CONTROL UNIT.

Provisions for controlling one navigation receiver, such as the 51R-3, and one transmitter, such as the 17L-4 or the 17M, are provided by the 614F-2 Frequency Control Unit. A schematic diagram and installation drawing are supplied with this issue (figures 12-12 and 12-37).

c. 478A-1 ZIFOR. *

Considerable difficulty has been experienced in adjusting the Collins 479S Audio Signal Generators or their military or commercial equivalents for an accurate north setting by the use of the interference pattern method. This technique is unwieldy and requires the use of special equipment such as a calibrated oscilloscope, a zero-phase-shift 30 cps filter, and a separate 9960 cps generator. The limits of accuracy of this method are such that, despite the use of extreme care by a technician of great skill, the north settings are often impossible to duplicate.

To provide greater accuracy in producing a north setting and to reduce the labor and time required, Collins has developed the 478A-1 Zifor. The 478A-1 Zifor provides the indications necessary to zero the 479S audio signal generators or their equivalents, with a minimum of effort.

The 478A-1 Zifor accepts a mixed signal consisting of a 30 cps variable phase signal and a 9960 cps carrier frequency-modulated by a 30cps reference phase signal. It indicates the coincidence in phase (corresponding to a north setting of the VOR signal generator) of the 30 cps variable phase signal and the 30 cps modulation of the 9960 cps f-m signal. The 478A-1 Zifor may be used in conjunction with any device providing one volt each of the aforementioned input signals. The 478A-1 Zifor may be used to check for phase shift in the modulator section of the Boonton 211A and similar r-f signal generators providing a demodulated output or it may be used to check the north setting of the Collins 479S series Audio Signal Generators or their equivalents.

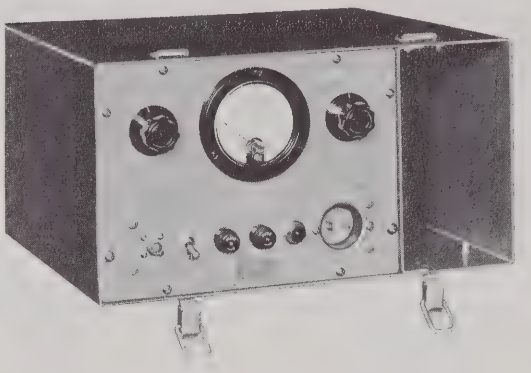

Figure 1-4. 478A-1 Zifor

d. 479T-2 SIGNAL GENERATOR.

For customers who wish to provide a more complete check of VOR and localizer functions then may be obtained through the use of the 479U-1, Collins has developed the 479T-2. Signal Generator.

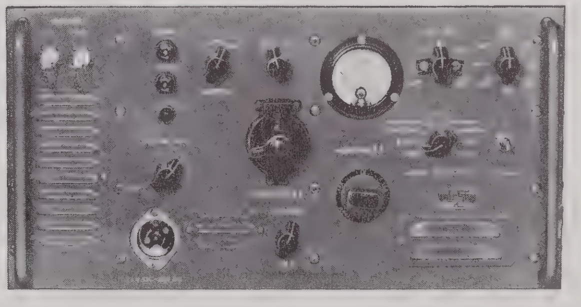

Figure 1-5. 479T-2 Signal Generator

e. 479V-2 PRECISION OMNI-BEARING SELECTOR.

(1) PURPOSE OF EQUIPMENT.

The Collins 479V-2 Precision Omni-Bearing Selector is designed specifically for use in testing and adjusting the Collins 51R-2 and 51R-3 Navigation Receivers which use rotor input resolvers.

The accuracy to which a VOR receiver can be checked or adjusted is dependent upon the accuracy of the OBS used with the radio.

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* Reg. US Pat. Off.

The 479V-2 provides a precise, stable and quick method of obtaining OBS settings.

(2) FEATURES.

The following features are incorporated in the incorporated in the 479V-2 Precision Omni-Bearing Selector.

(a) INCREASED ACCURACY. - The maximum runout error is ±0.05 degrees.

(b) HIGH STABILITY. - A faulty receiver may cause an excessive d-c current to flow through the resolver and seriously impair the accuracy of the OBS. The design of the 479V-2 is such that the runout error will not change under these adverse conditions.

(c) SMALL SIZE. - The 479V-2 mounts in a standard 19-inch relay rack on a 31-/2-inch panel. The depth of the chassis is approximately four inches.

(d) SAVES TEST TIME. - Receivers are ordinarily calibrated at 30° intervals. The 479V-2 is also calibrated in 30° steps selected by a switch, thus, selecting each OBS setting is fast and positive.

(e) ALLOWS RECEIVERS TO BE ADJUSTED IN A MORE PRECISE MANNER. - The 479V-2 stimulates a design center resolver as specified by RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA) COMMITTEE SC-61. The use of an OBS which meets this condition at all test stations results in uniform adjustment and operation of all receivers in the fleet, thereby tending to decrease the frequency of unscheduled removals. The TRACKING and VOR ZERO controls in a receiver can only be adjusted accurately when an accurate OBS is used with the receiver during adjustment. The VOR FLAG control for flag sensitivity can only be adjusted accurately when the OBS used during adjustment has an output level the same as a design center OBS.

(3) DESCRIPTION.

The 479V-2 is a combination of a precisely tapped transformer and a switching arrangement which provides a means of obtaining the required voltage ratios corresponding to a standard resolver output.

When used in a rotor input circuit it is electrically identical to a standard aircraft OBS containing a resolver with design center electrical characteristics.

The 479V-2 mounts in a standard 19-inch relay rack on a 3-1/2-inch panel. Connections to the 479V-2 are made to the terminal strip on the rear or through the AN connector on the front panel. This connector is identical with that on a standard aircraft OBS. The desired OBS setting is selected by means of a BEARING switch on the front panel calibrated in 30° increments. In addition the panel contains a TO-FROM indicator calibrated in microamperes. A locking type potentiometer is located at the rear to index the 479V-2 in accordance with RTCA standards. Figure 1-6 shows a test hook up using the 479V-2.

f. MODIFIED 416N-4 AND 416N-5 POWER SUPPLIES.

In some installations it is possible for the a-c power supply to be energized before d-c power is applied to the receiver. The receiver, with the tubes cold, provides unsufficient load for the a-c supply and the output of the a-c supply reaches an abnormally high value. To avoid this difficulty a modified 416N-4 and 416N-5 power supply is available which prevents the a-c power from being energized until the d-c power is applied. The modified 416N-4 bears part number 505 3705 003. The 416N-4 without the relay bears part number 505 3705 023. The part number of the modified 416N-5 power supply is 505 3706 003; the power supply without the relay is 505 3706 013.

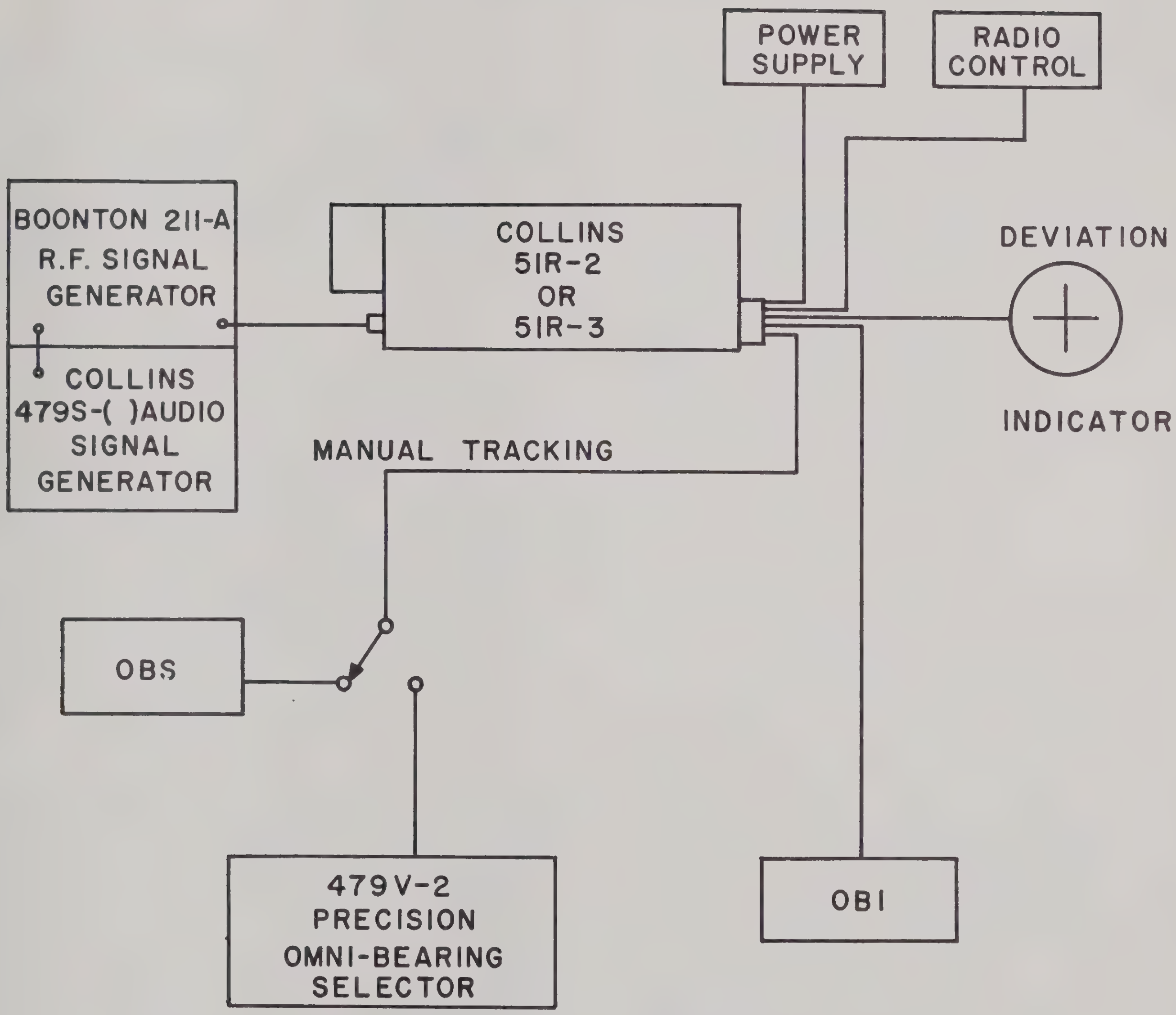

POWER SUPPLY
RADIO CONTROL
BOONTON 211-A R.F. SIGNAL GENERATOR
COLLINS 479S-( )AUDIO SIGNAL GENERATOR
COLLINS 51R-2 OR 51R-3
DEVIATION INDICATOR
MANUAL TRACKING
OBS
479V-2 PRECISION OMNI-BEARING SELECTOR
OBI

Figure 1-6. Block Diagram Showing Connections for Testing and Adjusting a 51R-2 or 51R-3 Receiver Using a 479V-2 Precision Omni-Bearing Selector

SECTION 2

INSTALLATION

2-1. UNPACKING.

Unpack the equipment carefully. Inspect each component for apparent damage. Check mechanical operations by rotating control knobs on instruments and inspect instruments for broken panel glass. Remove the receiver from its case and determine that all tubes are in their proper places.

2-2. PRE-INSTALLATION TESTS.

All pre-installation adjustments are made on the equipment before it leaves the factory. However, if facilities are available it is advisable to perform a line inspection and a bench check before installing the equipment. The line inspection is outlined in Section 8 paragraph 8-2. If a test harness is not available and bench connections have to be made, all cable lengths should be from 10 to 20% longer than they will be when installed. This eliminates the need for resoldering many of the connectors when the installation is made.

2-3. TYPES OF INSTALLATION.

The navigation receiving equipment used in any particular installation and its interconnections will depend on the type of aircraft, the service intended, desired functions, and power sources. Because 51R-3 Receiver installation arrangements are so numerous, no attempt is made to describe a large number of them. Instead, they will be divided into a typical "minimum installation" and a typical "maximum installation." There are two basic differences in the two installations. The minimum installation is position-sensitive only. It gives position relative to the selected course. The maximum installation is heading sensitive as well as position sensitive. The minimum installation gives omni-bearing only after a manual operation is performed. The maximum installation gives it automatically and continuously. That is, in addition to all the "minimum installation" services, the maximum installation gives aircraft heading and continuous automatic omni-bearing indications on the 332C-1 Radio Magnetic Indicator.

2-4. MINIMUM INSTALLATION.

The equipment and general cabling for a typical minimum installation are shown in figure 12-4. Up to three ID-48A Deviation Indicators may be connected in parallel when it is necessary to serve pilot, co-pilot and navigator. The power supply used would depend on the aircraft source voltage. The Type 416N-1 or 2 is used for 14 or 28 volt dc sources. The Type 416N-4 or 5 is used when the source voltage is 115 volt 400 cps. A source of 26 volts 400 cps is not required for the minimum installation.

2-5. MAXIMUM INSTALLATION.

The equipment and general cabling for a typical maximum installation is shown in figure 12-5. Interconnection details are shown in figure 12-6. A 337A Omni- Bearing Indicator is required for any installation giving automatic omni-bearing indications. In installations where it is not necessary to have the automatic omni-bearing indications on a stabilized magnetic scale the 337A Omni-Bearing Indicator may be mounted on the instrument panel and the 332C-1 Radio Magnetic Indicator and 333B Servo Amplifier may be omitted from the system. When the 332C-1 Radio Magnetic Indicator is used one 333B Servo Amplifier must be used for each Radio Magnetic Indicator. Connections to the aircraft's gyro stabilized magnetic compass system and 26 volts 400 cps are required for operation of the 332C-1 Radio Magnetic Indicator. The power supply used would depend on the aircraft source voltage. Up to two 337A Omni-Bearing Indicators, three 333B servo Amplifiers and two 416N Power Supplies may be mounted on the Type 351A Accessory Frame. A double shockmount is available for use with two 51R-3 Receivers, a receiver and an accessory frame, or a receiver and a Type 17L VHF Transmitter. A more elaborate installation may be had by using two 51R-3 Receivers.

2-6. LOCATION OF COMPONENTS.

a. 51R-3 RECEIVER. The receiver may be mounted in any convenient location. The radio compartment is the most suitable location from the standpoint of accessibility and cable lengths. Orientation in the horizontal plane is not important but the mounting surface should be level and rigid. Locations having minimum ambient temperature variations are highly desirable. Normal receiver temperature rise in still, open air is 25°C. A minimum clearance of 2 inches on the sides and 4 inches front and rear are necessary for removal and freedom of movement on the shockmount.

b. TYPE 37J-2 ANTENNA. The 37J-2 antenna should be mounted in the location that gives best localizer and omni-range reception for minimum propeller modulation effects. Experiments have determined that the location atop the vertical rudder is best for most airplanes. These experiments did not go into the results of severe icing conditions or static discharge effects. The second best location is on top of the fuselage over the cabin or passenger compartment but tail shadow causes nearly 19 db signal strength attenuation. Whatever its location, it must be shielded from radar and radio altimeter antennas by the aircraft structure. Also, it must be mounted so that its dipoles are in a horizontal plane when the aircraft is in normal flying attitude.

c. TYPE 314U FREQUENCY CONTROL UNIT. The remote control unit may be mounted in any location that is easily accessible and visible to the pilot. The engine control pedestal or overhead switch panel are two typical locations. The Type 314U-2 is designed for horizontal mounting, the 314U-5 and 8 for vertical mounting.

d. INSTRUMENTS. The ID-48A Deviation Indicator should be mounted on the instrument panel in plain view of the co-pilot or pilot in a position to make the parallax error a minimum. The 336A-2 Omni-Bearing Selector may be mounted in any location within reach and sight of the pilot or co-pilot. Although the instrument

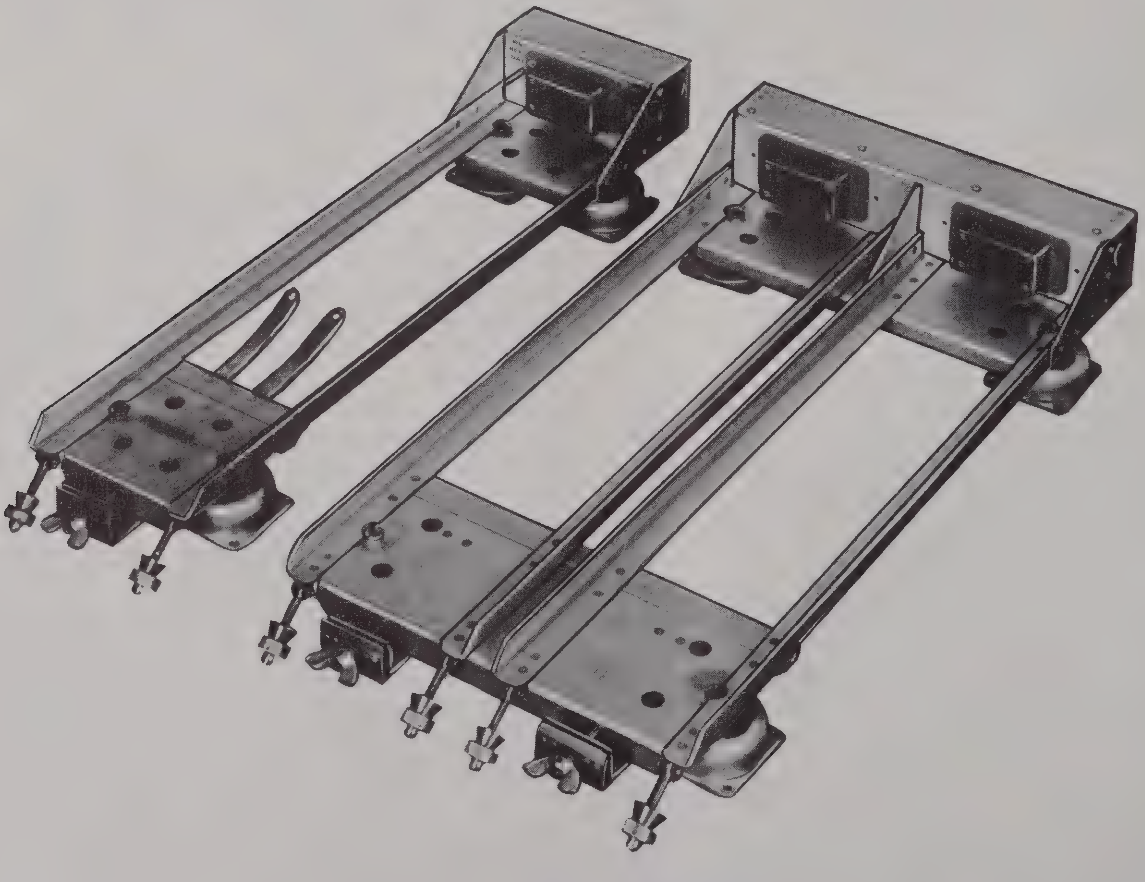


Figure 2-1 Single and Dual Shockmounts

panel is a convenient location it need not be mounted on a vertical panel. The 332C-1 Radio Magnetic Indicator should be mounted on the main instrument panel. In installations that use the 337A Omni-Bearing Indicator and not a 332C-1 Radio Magnetic Indicator, the Omni-Bearing Indicator should be mounted on the instrument panel. In installations that use a 332C-1 Radio Magnetic Indicator the 337A-2 Omni-Bearing Indicator may be mounted in any remote out-of-the-way place but preferably on the 351A Accessory Frame.

e. 416N POWER SUPPLY AND ACCESSORIES. The power supplies may be installed in any convenient location, but mounting on the 351A Accessory Frame and mounting the accessory unit in the radio compartment is the most desirable arrangement. Minimum cable lengths are maintained by mounting the power supplies on the accessory frame and the accessory frame next to the receiver. The 333B-1 Servo Amplifier is mounted in the 351A Accessory Frame. If an accessory unit is not used, the 333B-3 Servo Amplifier is used and it is located in the radio compartment.

2-7. MOUNTING COMPONENTS.

a. SHOCKMOUNTS. Single or dual shockmounts are available for any particular type of installation desired. By changing the shockfeet and/or one rear receptacle the basic dual shockmount shown in figure 2-1 may be made to accommodate any of the combinations used. Table 2-1 below lists the single and dual shockmounts by Collins Part Number together with the equipment they are intended to carry:

Table 2-1.

<table>
<tr><th>Type No.</th><th>Description</th><th>Part No.</th><th>Mounts</th></tr>
<tr><td>350E-2</td><td>Single 1/2 ATR</td><td>504 3713 001</td><td>One 51R-1, 2, 3 or one 351A-1 with single automatic instrumentation. *</td></tr>
<tr><td>350K-1</td><td>Single 1/2 ATR</td><td>520 3960 00</td><td>One 351A-1 with dual automatic instrumentation. **</td></tr>
<tr><td>350G-3</td><td>Dual 1/2 ATR</td><td>505 2342 004</td><td>One 51R-1, 2, or 3, and one 351A-1 with single or dual automatic instrumentation Any combination of two 51R-1, 2, or 3's.</td></tr>
<tr><td>350F-2</td><td>Dual 1/2 ATR</td><td>505 2679 004</td><td>One 51R-1, 2, or 3 and one 17L-2.</td></tr>
<tr><td colspan="4">NOTE
This shockmount is identical to the Type 350G-3 except for one rear receptacle being different to accomodate the 17L-2 transmitter.</td></tr>
<tr><td>350E-1</td><td>Single 1/2 ATR</td><td>520 3959 00</td><td>One 51R-1 or 351A-1 with single automatic instrumentation.</td></tr>
<tr><td>350F-1</td><td>Dual 1/2 ATR</td><td>504 4267 004</td><td>One 51R-1, 2, or 3 and one 17L-2.</td></tr>
<tr><td>350G-1</td><td>Dual 1/2 ATR</td><td>504 4268 004</td><td>One 51R-1, 2, or 3 on right side only and one 351A-1 with dual automatic instrumentation.</td></tr>
<tr><td>350G-2</td><td>Dual 1/2 ATR</td><td>504 5302 004</td><td>One 51R-1, 2, or 3 on right side only and one 351A-1 with single automatic instrumentation.</td></tr>
</table>

* 351A-1 Equipped for single automatic instrumentation includes:

(1) One 351A-1 Accessory Frame
(2) One 416N Power Supply
(3) One 333B-1 Servo Amplifier
(4) One 337A Omni-Bearing Indicator

** 351A-1 equipped for dual automatic instrumentation includes:

(1) One 351A Accessory Frame
(2) Two 416N Power Supplies
(3) Two or three 333B-1 Servo Amplifiers
(4) Two 337A Omni-Bearing Indicators

Dual shockmount number 505 2342 004 may be made to accommodate one 51R-1, 2, or 3 and one 17L-2 Transmitter by changing the rear receptacle on the transmitter side. The shockfeet remain the same.

b. 51R-3 RECEIVER. The 51R-3 Receiver must be mounted on the single or double shockmount. The shockmount is mounted on a rigid level surface using 16 each 5/16 inch holes arranged as shown in figure 12-22. It is attached with 16 #10-32 screws, lock washers, and nuts. See figure **12-26** for receiver outline drawing.

c. TYPE 37J-2 ANTENNA. When mounting the 37J-2 Antenna a rubber gasket should be used between the bottom of the antenna and the skin of the aircraft to act as a seal. Also the mounting base strength should be increased by mounting a 12 gauge rectangular aluminum plate inside the aircraft and under the antenna base. A base plate is provided for mounting on pressurized aircraft. Drill holes according to the drawing of figure **12-38**. Apply a paste gasket material such as Permatex or Parkers Unipar to base of antenna mast before fastening to the aircraft. Secure the antenna to the aircraft with #10-32 flat head screws. Anchor nuts that can be riveted to the aluminum plate are recommended.

d. TYPE 314U FREQUENCY CONTROL UNIT. This unit may be mounted from the rear of the aircrafts' control panel or a separate panel may be cut out and used. When mounting from the rear of the panel in the aircraft, cut out the aircrafts control panel according to the drawing at left of figure **12-33**. When using a separate panel make cutout according to the drawing at the right of figure **12-33**. The panel for this cutout must be 1/16" thick. In either installation use four 6-32 screws, lock washers, and nuts. Ample space must be allowed at the bottom for the cable. This cable is wired directly to the switches and is cut to about 18 inches.

e. INSTRUMENTS. The 336A Omni-Bearing Selector, ID-48A Deviation Indicator, 337A Omni-Bearing Indicator, and 332C-1 Radio Magnetic Indicator are all standard three inch instruments, and may be mounted in the front or rear of the instrument panel. Panel cutout for the Deviation Indicator differs slightly from the standard three inch cutout. See figure **12-22** for Deviation Indicator cutout drawing. Dimensions, clearances, and schematics are shown for all the instruments in figures **12-22** through **12-25**. Use Tinnerman nuts supplied with instruments for behind-the-panel mounting.

f. TYPE 416N POWER SUPPLIES. The Type 416N-1 Power Supply is designed for mounting on the rear of the 351A-1 Accessory Frame. Four screws secure it to the accessory frame. This power supply may be mounted on a special mounting base, Collins Part No. 503 6648 003, which, in turn is secured to the aircraft by a mounting plate identified as part number 503 6645 002. Two captive screws hold the mounting base to the mounting plate and four .203 inch mounting holes are provided in the mounting plate for securing it to the aircraft. See figure **12-30** for layout. The 416N-2 Power Supply is not adapted to mounting on the accessory frame. It fastens to mounting plate #503 6645 002 directly and is secured with two captive screws. See figures 12-30 and 12-31. The Type 416N-4 and 416N-5 A.C. Power Supplies are designed to mount on the rear of the 351A-1 Accessory Frame or on the special mounting base in the same manner as the 416N-1 Power Supply.

2-8. INTERCONNECTIONS.

a. WIRING. Figure 12-6 is an interconnections diagram for the maximum installation. All interconnection cabling must be made up. Except for primary power leads, wire sizes are not particularly important since the currents they carry are small. Primary power leads should be A.W.G. #12 wire. A.W.G. #18 wire is recommended for filament and B+ leads. All other leads may be #20 wire. All shielding indicated in figures 12-3 and 12-6, must be used. Advantage should be taken of the natural shielding obtained in running cables near the aircraft structure and along longerons.

Two methods may be used to connect two receivers to the same antenna. A coaxial cable from the antenna may be connected to a Tee connector and the receivers connected to the Tee by use of two cables that are equal in length and multiples of 0.5 wavelength at 122 mc (31.5 inches). The alternate connection procedure is to connect the Tee directly to one receiver and connect the other to the Tee through a cable that is a multiple of 31.5 inches in length. The first method is preferred since it results in more nearly equal signal inputs to the receivers. The length of the cable from the antenna to the Tee is not critical and may be made any length that good wiring practice dictates. Cabling to a shockmounted unit should be long enough to permit free movement of the unit on its shockmount.

NOTE

> Terminals A and C of omni-bearing selector receptacle must be grounded to shockmount receptacle pin number 42 using separate wires. Shields of wires to shockmount receptacle must be connected separately to pin number 42.

b. TYPE 332C-1 RADIO MAGNETIC INDICATOR CONNECTIONS. To simplify the service problem when more than one type of Radio Magnetic Indicator is used, the 333B-1 Servo Amplifiers have been made identical and an autotransformer, Collins Part No. 677 0255 00, has been designed to match the high impedance motor winding of Pioneer Type 36101 Radio Magnetic Indicators. Figure 12-14 shows the autotransformer and adapter cable that made the Radio Magnetic Indicators interchangeable. This connection necessitates a change in the Kearfott Radio Magnetic Indicator consisting of removing the internal ground from pin V.

c. DEVIATION INDICATOR CONNECTIONS. The Deviation Indicator circuits are designed for a 333 ohm load on the crosspointer circuits and a 500 ohm load on the flag alarm circuit. Each Deviation Indicator movement and each flag alarm movement represents 1000 ohms. Resistors (1/2 watt) should be used when movements in parallel are too few to maintain the 333 ohm and 500 ohm loadings.

Other course indicators such as Course Indicator ID-249/ARN, Course Indicator ID-249A/ARN, Bendix Omni-Mag and the Collins 331A-1 may be used in place of the Deviation Indicator. These instruments have internal magnetic damping sufficient to eliminate the need for more than 1250 mfd of course wiggle filter capacity. This low voltage non-polarized electrolytic capacitor should be connected directly across the instrument. If Deviation Indicator ID-48 is used, an additional capacitance may be connected across the instrument on VOR operation to provide improved filtering. Internal switching facilities have been provided on all receivers bearing serial number 1068 and larger to connect a 3750 mfd capacitor across the deviation indicator. The capacitor should connect between pin 6 and 41 of the shockmount receptacle. For receivers with serial numbers below 1068, refer to applicable service bulletin.

d. POWER SOURCE CONNECTIONS. The 400 cps power supplied to the accessory unit should preferably come from an autotransformer, Collins Part No. 672 0262 00. An alternate arrangement can be used where the autotransformers in the 333B-1 Servo Amplifiers supply one synchro motor rotor as well as the Radio Magnetic Indicator servo motor. The 26 volt winding on autotransformer T-603 in the 333B-1 Servo Amplifier has a rating of 460 ma. at 26 volts. Approximate power requirements for synchro motor rotors, OBI and RMI motors are as follows:

	STATIC	DYNAMIC
(1) Synchro motor rotor	100 ma.	100 ma.
(2) OBI motor	150 ma.	230 ma.
(3) RMI motor	150 ma.	230 ma.

NOTE

> The 400 cps power to the 333B Servo Amplifier and RMI must come from the same source that is used for synchro generator in the gyro stabilized magnetic compass system.

e. COMPASS DATA SYNCHRO GENERATOR CONNECTIONS. Installation information outlined in this instruction book covers installation of the 51R-3 receiver and accessories in an aircraft equipped with a Gyrosyn compass. Where the installation is made in an aircraft equipped with the Eclipse-Pioneer Fluxgate Compass, two basic factors must be considered; otherwise, considerable confusion will result. The Sperry Corporation, manufacturers of the Gyrosyn and the Eclipse-Pioneer people do not employ the same definition of electrical zero. By using the Eclipse-Pioneer definition, it is found that their equipment will be electrically zeroed on North, whereas the Sperry equipment will be electrically zeroed on South. By following instructions outlined herein the magnetic information from the Fluxgate Compass can be effectively reversed without modification of the omni-range receiving equipment. Changes in the wiring in the aircraft only will be necessary. First, the RMI card, when using the 333B-1 or 333B-3 Servo Amplifier, will be 180 degrees from its proper bearing. To reverse this, it is suggested that the airplanes' wiring to the RMI servo motor stator terminals F and J be reversed. This will return the card to the proper zero reading for North magnetic heading.

The second point to be corrected is that the RMI pointers will be receiving South information, and must be reversed 180 degrees. It is recommended that the phase of the 26 volt 400 cps supplied to the RMI pointers be reversed by a 1:1 autotransformer. By connecting the autotransformer between the power source feeding the rotors and effecting the phase reversal no other instrumentation in the pilots compartment has been disturbed. Such a transformer is available and carries Collins Part No. 677 0327 00.

2-9. REMOTE SQUELCH CONTROL.

a. A remote squelch control may be added by connecting a 10,000 ohm linear variable resistance between pin 35 of connector P101 and ground. On Type 51R-3 receivers serial numbers 1 through 938 no further procedure is required. On receivers bearing serial numbers 939 and above, a jumper across R126 must be removed.

b. On receivers bearing serial numbers 1 through 938, increasing the resistance of the remote squelch control provides a decreasing squelch threshold. On receivers with serial numbers of 939 and greater, increasing the resistance of the remote squelch control provides an increasing squelch threshold. Consequently, the two groups of receivers are not interchangeable without modification. Type 51R-3 receivers bearing serial numbers 939 and above are interchangeable, in as far as remote squelch is concerned, with the Type 51R-1 and 51R-2 receivers. Receiver sensitivity is not altered by the setting of the remote squelch control on serial numbers 1 through 938. In all receivers with greater serial numbers, the receiver sensitivity is variable as a function of the remote squelch setting.

IMPORTANT WIRING NOTICE

1. To eliminate losing localizer operation by accidentally throwing the 314U PHASE/TONE switch to PHASE, and to facilitate localizer operation when utilizing the 314U-8 control unit (no PHASE/TONE switch available), it is necessary to ground pin 22 of the 51R shockmount connector.

2. The antenna changeover function of the 51R-3 Receiver has been changed from 122 mc to 118 mc. The change is effective with serial number 1488 and above. The proper wiring associated with this change is illustrated in the schematic and wiring diagrams for receivers with serial numbers 1696 and above. The change consists of removing the wire from position 9 on S-102 and transferring it to position 7. The other end of the wire terminates at terminal 23 of P-101.

3. Effective with 51R-3 Receiver serial number 2401 and all larger serial numbers, the avc time constant switching circuits have been changed. The changes are reflected in the schematic and wiring diagram.

SECTION 3

OPERATION

3-1. TYPES OF RECEPTION.

The 51R-3 Navigation Receiver and its accessories provide reception of localizer, vhf omni-range and voice facilities in the spectrum from 108 through 135.9 mc. Switching to obtain the three different types of reception is not required, as the circuit functions are changed automatically when the frequency is selected.

3-2. FREQUENCY COVERAGE.

The spectrum from 108 through 135.9 mc is divided into bands according to the type of reception. Present assignments in these bands are as follows:

BAND	FUNCTION
108.0 - 111.9 mc	Localizer
112.0 - 117.9 mc	Omni-Range
118.0 - 121.9 mc	Tower (voice)
122.0 - 135.9 mc	Communications

The receiver, as it leaves the factory, is wired to correspond to the frequency assignments shown above or the assignments existing at the time of delivery. If the assignments are changed after the receiver leaves the factory the receiver switching must be changed by a simple procedure detailed in Section 8, Maintenance.

3-3. OPERATING RANGE.

Reception of signals in the band used for omni-range navigation aids is limited essentially to line-of-sight paths. Ground obstructions and the curvature of the earth limit low altitude operation to a relatively short distance. As the altitude is increased the operating range increases in proportion. Figure 3-1 is a curve showing the manner in which operating range increases with increase in altitude. It is derived from calculations based on the curvature of the earth. Operating ranges somewhat greater than those indicated in figure 3-1 may be encountered in practice.

3-4. CONTROLS AND INDICATIONS. (See figure 3-2.)

a. FREQUENCY SELECTOR. The frequency channel is selected by concentric knobs (1) on the 314U Frequency Control Unit. The frequency selected is indicated in the vertical MEGACYCLES window (2).

b. OMNI-BEARING SELECTOR. The desired omni-bearing is selected by a knob (3) on the right side of the 336A-2 Omni-Bearing Selector. The omni-bearing selected is indicated by a counter type dial (4). A TO-FROM indicator (5) indicates whether the omni-bearing selected is the course to or from the omni-range station. See figure 3-3. A TO-FROM division line, line A-B, intersects the 30-210 omni-bearing line at right angles at the station. With a course of 30 degrees set into the MAGNETIC BEARING window the TO-FROM indicator will indicate TO when the aircraft is in any position south of the TO-FROM division line A-B regardless of the heading of the aircraft. When the aircraft is in any position north of the line A-B the TO-FROM indication is FROM for a MAGNETIC BEARING setting of 30 degrees.

c. TO-FROM SWITCH. A TO-FROM switch (7) on the left side of the omni-bearing selector reverses the TO-FROM indication and changes the MAGNETIC BEARING indication 180°

d. VERTICAL NEEDLE. The vertical needle (8) indicates the on-course, off-course, condition of the aircraft regardless of the heading. The following positions of the vertical needle are of significance.

(1) The vertical needle will be centered when the aircraft is on the omni-bearing line indicated in the MAGNETIC BEARING window.

(2) The vertical needle is displaced in the direction of the desired omni-bearing line set into the MAGNETIC BEARING window under the following conditions:

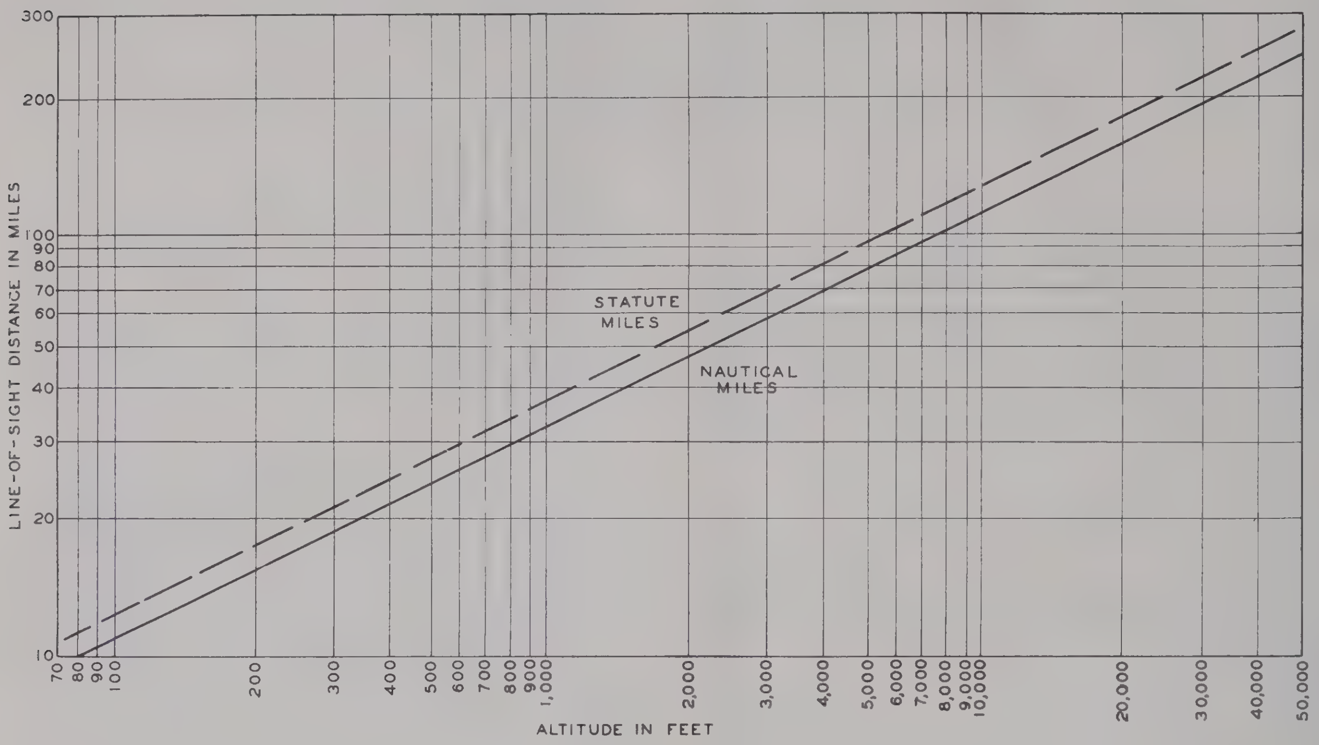


Figure 3-1 Operating Range vs Altitude

(a) When the aircraft is off course, headed toward the station, and the TO-FROM indication is TO.

(b) When the aircraft is off course, headed away from the station, and the TO-FROM indication is FROM.

Thus, it can be seen that the general heading of the aircraft in relation to the station must agree with the TO-FROM indication in order to interpret the vertical needle with normal sensing. That is, if the aircraft is headed, roughly, toward the station the TO-FROM indicator must indicate TO, and if the aircraft is headed, roughly, away from the station the TO-FROM indicator must indicate FROM for the vertical needle to be interpreted with normal sensing.

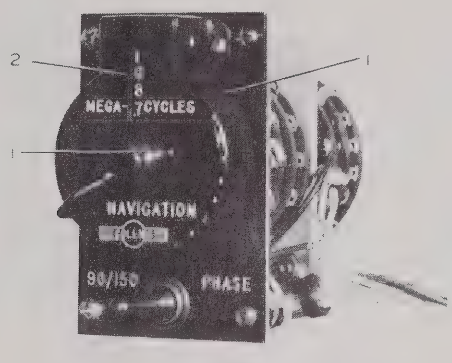
(3) Full scale deflection is indicated when the needle is displaced to the second dot from center. Full scale deflection corresponds to 10 degrees.

e. FLAG ALARM. Two flag alarms (12), (13), labeled OFF, one for the vertical needle and one for the horizontal needle, come into view at any time signal levels fall below a value sufficient to provide reliable operation of the equipment associated with each flag.

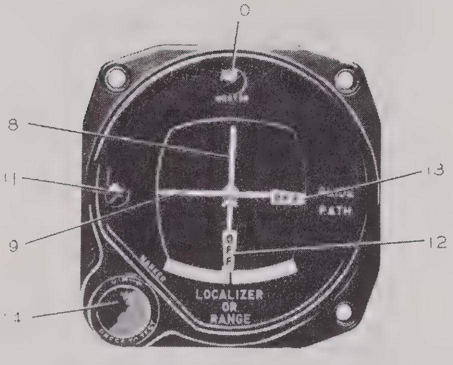
f. HORIZONTAL NEEDLE. The horizontal needle (9) is used in glide slope operation. For operation of this needle consult handbook of instructions for the glide slope receiver.

g. OMNI-BEARING INDICATION. The fixed index (15) at the top of the 337A-2 Omni-Bearing Indicator indicates the magnetic bearing of the omni-range from the aircraft. This indication is operative only when a vhf omni-range station is selected on the 314U Frequency Control Unit. The omni-bearing is also indicated by the double barred pointer (16) on the azimuth scale (17) of the 332C-1 Radio Magnetic Indicator.

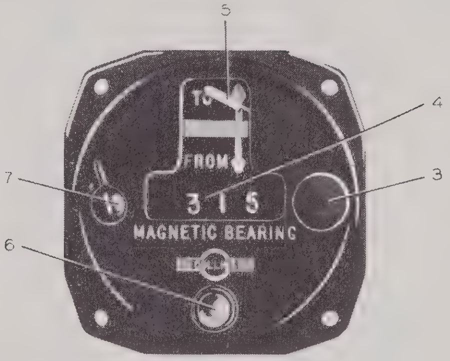
h. HEADING INDICATION. The fixed index (18) at the top of the 332C-1 Radio Magnetic Indicator indicates the magnetic heading of the aircraft on the azimuth scale.


2
1
1
MEGA- CYCLES
NAVIGATION
90/150
PHASE

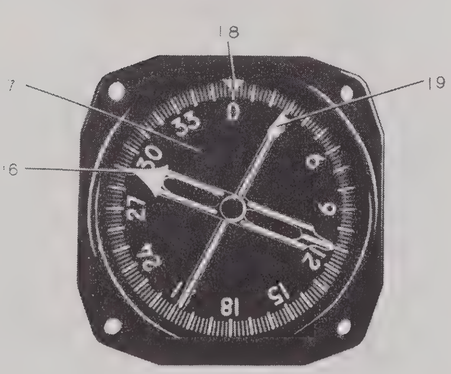
314U-5 CONTROL UNIT


0
8
11
13
9
12
14
PATH
OFF
LOCALIZER OR RANGE

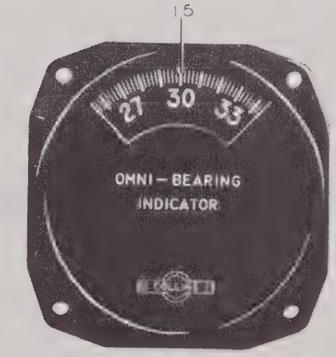
ID-48 DEVIATION INDICATOR


5
4
7
3
6
TO
FROM
3 1 5
MAGNETIC BEARING

336A-2 OMNI-BEARING SELECTOR


18
17
19
16
0
3
6
9
12
15
18
21
24
27
30
33

332C-2 RADIO MAGNETIC INDICATOR


15
27
30
33
OMNI—BEARING INDICATOR

337A-2 OMNI-BEARING INDICATOR

(1) Concentric Knobs
(2) Megacycles Window
(3) Selector Knob
(4) MAGNETIC BEARING Window
(5) TO-FROM Indicator
(6) Lamp
(7) TO-FROM Switch
(8) Vertical Needle
(9) Horizontal Needle
(10) Vertical Needle Adjustment
(11) Horizontal Needle Adjustment
(12) Vertical Needle Flag
(13) Horizontal Needle Flag
(14) Marker Lamp
(15) OBI Index
(16) Double Barred Pointer
(17) Azimuth Scale
(18) Heading Index
(19) Single Barred Pointer

Figure 3-2 Operating Controls and Indicators

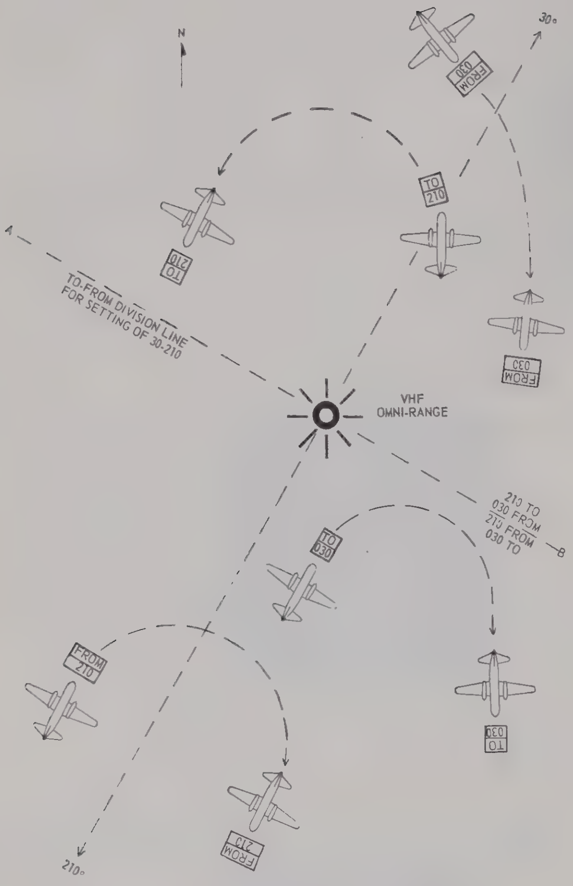


Figure 3-3 Diagram Relating TO-FROM To MAGNETIC BEARING Indications

3-5. OPERATING PROCEDURE.

Step 1 TURNING ON.

The navigation receiving equipment is energized and ready to operate when the master switch in the airplane is turned on.

Step 2 CHANNEL SELECTION.

Turn the concentric knobs on the Frequency Control Unit until the desired channel appears in the vertical window.

CAUTION

After selecting the desired channel make certain that the flag alarm on the deviation indicator is out of sight.

Step 3 ORIENTATION. (See A, Figure 3-4)

Note omni-bearing indicated by double barred pointer on RMI. This is the bearing of the station from the aircraft; ie, the omni-bearing. Also note aircraft's heading on RMI index.

NOTE

The RMI omni-bearing indication can be double checked by changing bearing on OBS until centering of the vertical needle is obtained. If omni-bearing on RMI is 180° from bearing on OBS, turn reversing switch on OBS. OBS and RMI omni-bearings should agree ±2 degree. TO-FROM indication should be TO.

Step 4 BEARING SELECTION.

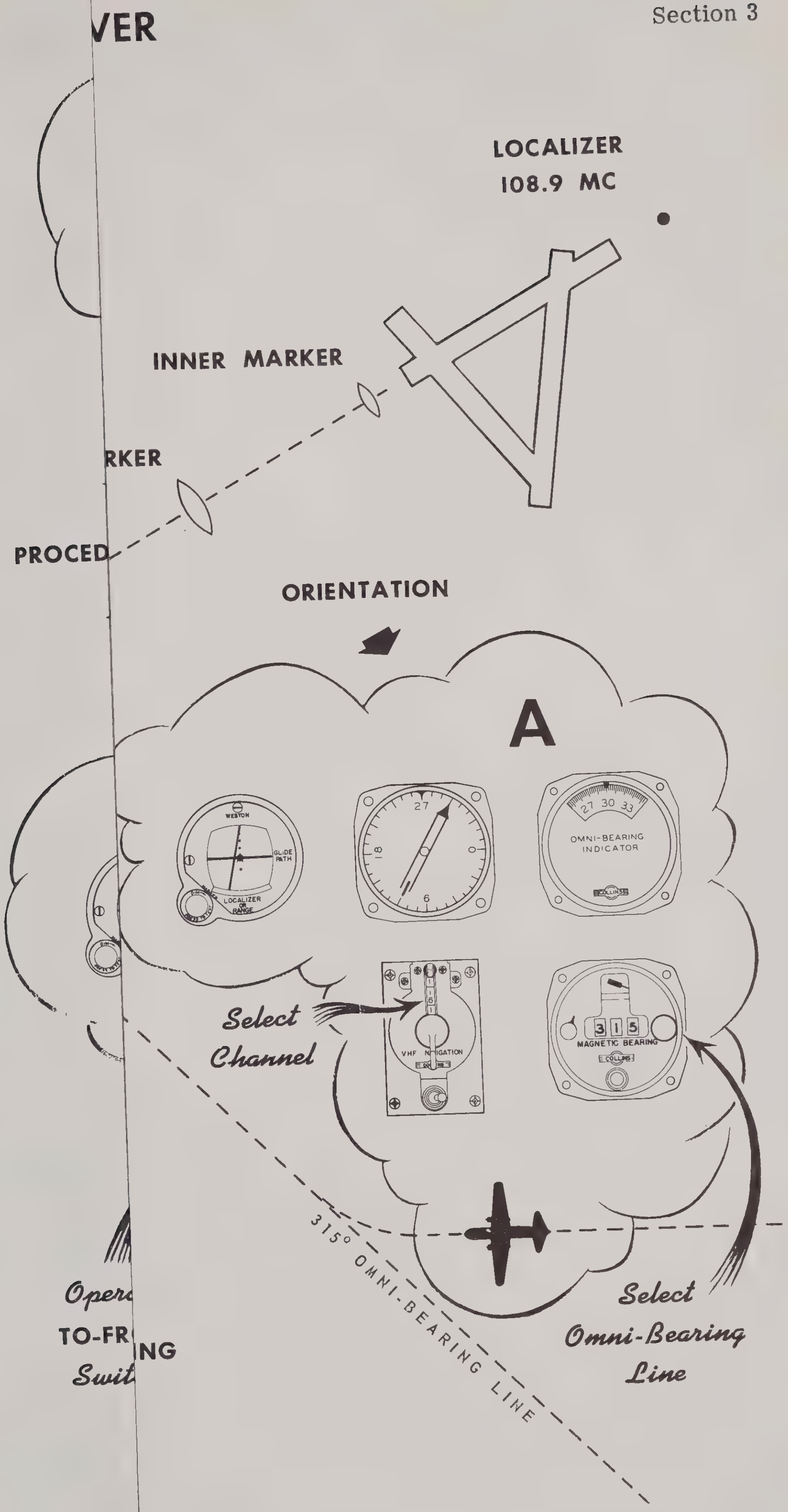
On basis of aircraft's bearing from station determined in step 3 above, determine desired radial, to or away from station, and set on OBS with knob provided.

Step 5 FLYING OMNI-RANGE. (See B, Figure 3-4)

For simple homing, center vertical needle with OBS (TO-FROM indication TO) and steer aircraft to keep vertical needle centered. Left needle indicates course is to left, right needle.... to right. As the aircraft passes over the station through the cone of confusion the vertical needle will swing from side to side, the TO indication will change to FROM, and the RMI double barred pointer will rotate 180° and point toward the station which is now directly behind the aircraft.

Step 6 PROCEDURE TURN. (See D, E, F, Figure 3-4)

While over the station turn OBS to reciprocal of final approach course. TO-FROM indication will be FROM. Steer aircraft to keep vertical needle centered. After proper elapsed time turn 45° from course. After 1-1/2 minutes start standard rate (needle width) turn away from station. In this turn operate reversing switch on OBS. TO-FROM indication will be TO, bearing indication will be final approach course. After 180° of turn, steer aircraft to center vertical needle and select localizer channel on Frequency Control Unit.


VER
LOCALIZER
108.9 MC
INNER MARKER
RKER
PROCED
ORIENTATION
A
WESTON
GLIDE PATH
LOCALIZER OR RANGE
27
18
0
6
27 30 33
OMNI-BEARING INDICATOR
COLLINS
Select Channel
VHF NAVIGATION
315
MAGNETIC BEARING
COLLINS
315° OMNI-BEARING LINE
Select Omni-Bearing Line
Oper
TO-FR
NG
Swit

4. Operating Chart

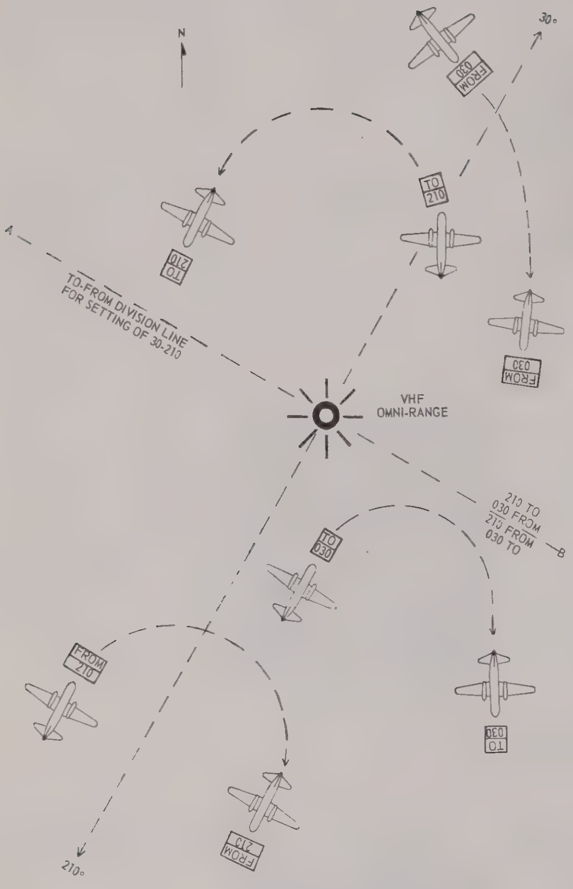


Figure 3-3 Diagram Relating TO-FROM To MAGNETIC BEARING Indications

3-5. OPERATING PROCEDURE.

Step 1 TURNING ON.

The navigation receiving equipment is energized and ready to operate when the master switch in the airplane is turned on.

Step 2 CHANNEL SELECTION.

Turn the concentric knobs on the Frequency Control Unit until the desired channel appears in the vertical window.

CAUTION

After selecting the desired channel make certain that the flag alarm on the deviation indicator is out of sight.

Step 3 ORIENTATION. (See A, Figure 3-4)

Note omni-bearing indicated by double barred pointer on RMI. This is the bearing of the station from the aircraft; ie, the omni-bearing. Also note aircraft's heading on RMI index.

NOTE

The RMI omni-bearing indication can be double checked by changing bearing on OBS until centering of the vertical needle is obtained. If omni-bearing on RMI is 180° from bearing on OBS, turn reversing switch on OBS. OBS and RMI omni-bearings should agree ±2 degree. TO-FROM indication should be TO.

Step 4 BEARING SELECTION.

On basis of aircraft's bearing from station determined in step 3 above, determine desired radial, to or away from station, and set on OBS with knob provided.

Step 5 FLYING OMNI-RANGE. (See B, Figure 3-4)

For simple homing, center vertical needle with OBS (TO-FROM indication TO) and steer aircraft to keep vertical needle centered. Left needle indicates course is to left, right needle.... to right. As the aircraft passes over the station through the cone of confusion the vertical needle will swing from side to side, the TO indication will change to FROM, and the RMI double barred pointer will rotate 180° and point toward the station which is now directly behind the aircraft.

Step 6 PROCEDURE TURN. (See D, E, F, Figure 3-4)

While over the station turn OBS to reciprocal of final approach course. TO-FROM indication will be FROM. Steer aircraft to keep vertical needle centered. After proper elapsed time turn 45° from course. After 1-1/2 minutes start standard rate (needle width) turn away from station. In this turn operate reversing switch on OBS. TO-FROM indication will be TO, bearing indication will be final approach course. After 180° of turn, steer aircraft to center vertical needle and select localizer channel on Frequency Control Unit.

OPERATION OF COLLINS 51R-3 NAVIGATION RECEIVER

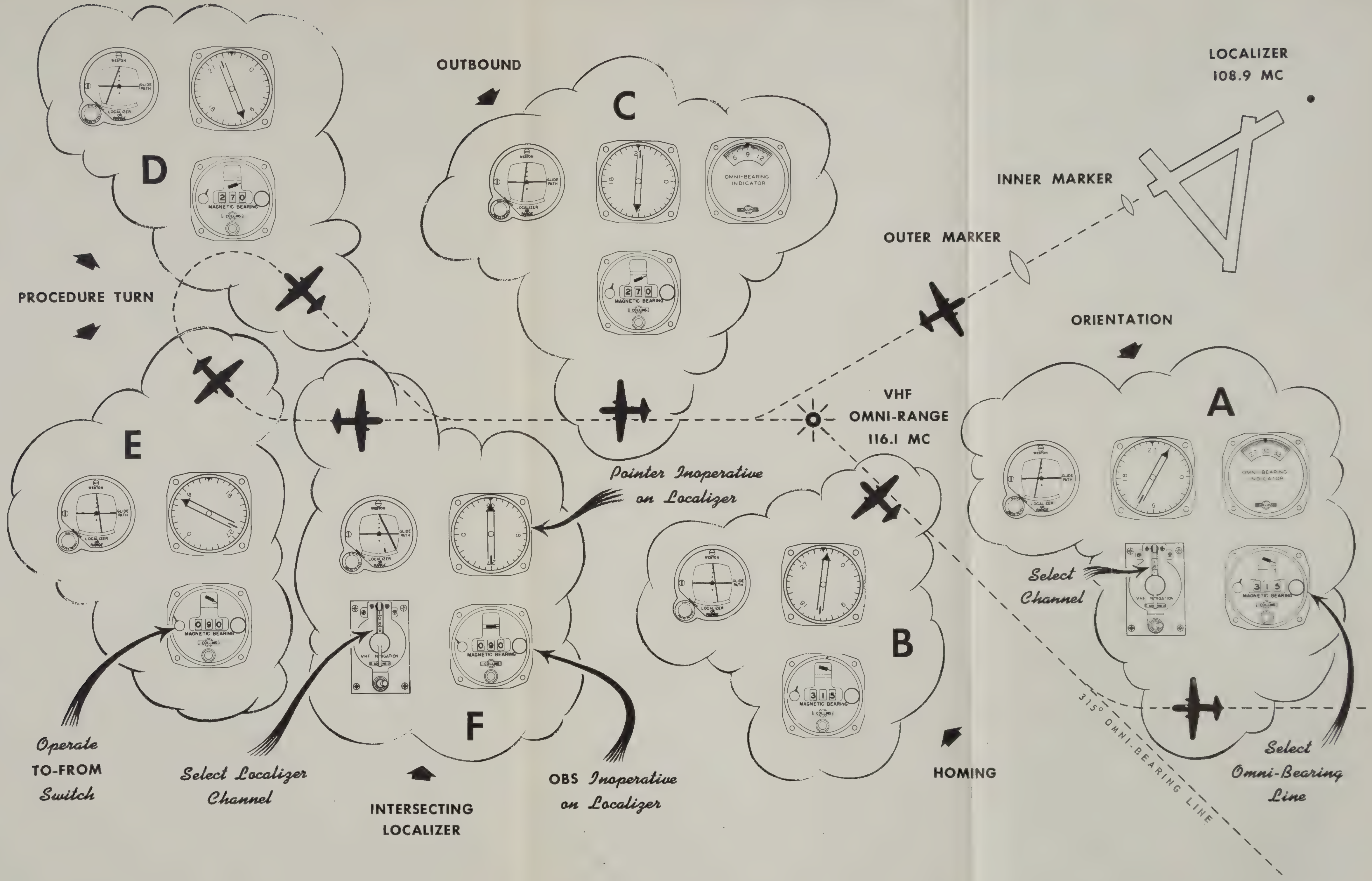
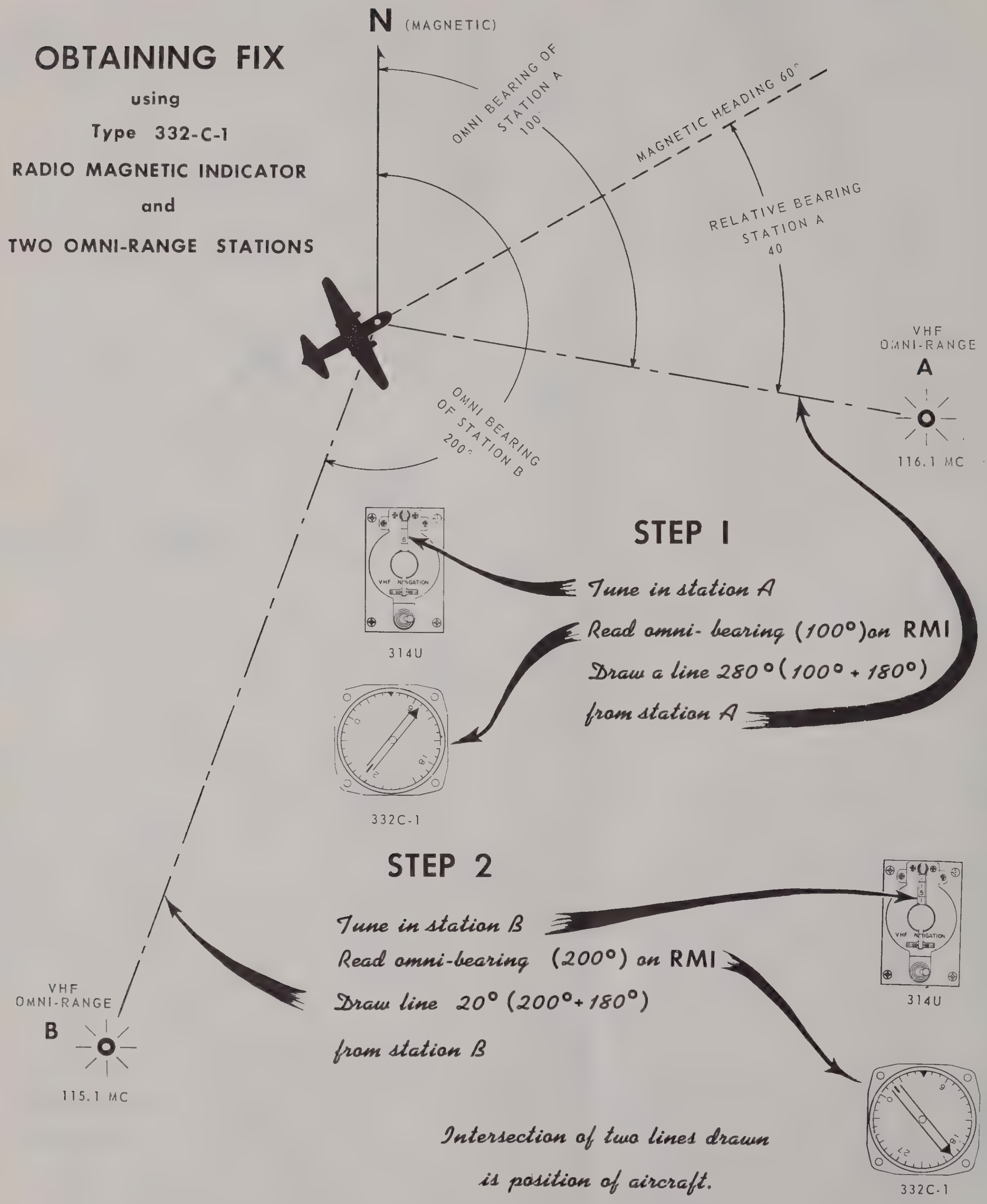

LOCALIZER
108.9 MC
INNER MARKER
OUTER MARKER
ORIENTATION
VHF
OMNI-RANGE
116.1 MC
OUTBOUND
C
D
PROCEDURE TURN
E
F
A
B
Pointer Inoperative on Localizer
Select Channel
Select Omni-Bearing Line
315° OMNI-BEARING LINE
HOMING
OBS Inoperative on Localizer
INTERSECTING LOCALIZER
Select Localizer Channel
Operate TO-FROM Switch
270
090
315
MAGNETIC BEARING
OMNI-BEARING INDICATOR
LOCALIZER
GLIDE PATH
VHF NAVIGATION

Figure 3-4. Operating Chart



OBTAINING FIX
using
Type 332-C-1
RADIO MAGNETIC INDICATOR
and
TWO OMNI-RANGE STATIONS

STEP 1

Tune in station A
Read omni- bearing (100°) on RMI
Draw a line 280° (100° + 180°)
from station A

STEP 2

Tune in station B
Read omni-bearing (200°) on RMI
Draw line 20° (200° + 180°)
from station B

Intersection of two lines drawn
is position of aircraft.

N (MAGNETIC)
OMNI BEARING OF STATION A 100°
MAGNETIC HEADING 60°
RELATIVE BEARING STATION A 40
VHF OMNI-RANGE A
116.1 MC
OMNI BEARING OF STATION B 200°
VHF NAVIGATION
314U
332C-1
VHF OMNI-RANGE B
115.1 MC
VHF NAVIGATION
314U
332C-1

Figure 3-5. Obtaining Fix Using RMI and Two Stations

SECTION 4

THEORY OF OPERATION

4-1. INTRODUCTION.

A complete understanding of the fundamental principles and techniques used in the Collins 51R-3 Navigation Receiver is essential to the proper maintenance and trouble shooting of the equipment. The overall picture of "How it works" can best be seen by (1) establishing firmly in mind what functions are preformed, (2) understanding the technique used to perform each of these functions, and (3) correlating these techniques with the actual physical components or parts of the equipment. This order is followed in the discussions of Sections IV and V.

4-2. FUNCTIONS PERFORMED.

The primary functions of the 51R-3 receiving equipment are to enable the operator to select, identify and accurately locate a line of position (omni-bearing line) through the vhf omni-range and to furnish voice and localizer services. This involves reception of the transmitted signal, accurate and rapid selection of station and course, aural output for voice communication and station identification, course deviation indication, flag alarm indications, and TO-FROM indications for bearing sensing. Continuous omni-bearing and magnetic heading indications may be had by inclusion of the Radio Magnetic Indicator and the 333B Servo Amplifier in the installation. All of these functions are described in the first three sections of the handbook. To understand how these basic requirements are met, a brief review of the vhf omni-range system is helpful.

NAVIGATION SECTION

4-3. VHF OMNI-RANGE PRINCIPLE.

The radiating system of the VHF omni-range consists of four antennas arranged in the form of a square around a center loop antenna. See figure 4-1. The carrier from the transmitter is amplitude modulated by a 9960 cps subcarrier. The subcarrier itself is frequency modulated at 30 cps. This carrier is fed to the center antenna where it is radiated in a non-directional pattern to supply the reference phase 30 cps signal. The purpose of the subcarrier modulation is to provide a means of discriminating between the 30 cps reference phase signal and the 30 cps variable phase signal at the receiver. The other four antennas are fed in pairs so that the voltage of one antenna is 180° out of phase with that of the next antenna. Thus the four antennas form two figure-of-eight patterns which are in both space and time phase quadrature. They can be visualized as a single figure-of-eight pattern with a positive lobe and negative lobe rotating 1800 rpm to produce amplitude modulation (in space) of the main r-f carrier transmitted from the center antenna. The resultant rotating field (somewhat like a rotating eccentric circle) generates a 30 cps signal in the receiver due to its rotation. This 30 cps signal is known as the variable phase signal. Figure 4-1 shows the figure-of-eight pattern and the resultant rotating field for every 45 degree position from 0° to 225°. The phasing of the two signals at the transmitter is adjusted so that the 30 cps reference phase signal and the 30 cps variable phase signal are in phase at magnetic north. That is, the 30 cps reference phase signal is zero phase at the instant the maximum of the rotating field has a direction exactly magnetic north. Measurement of the phase angle between the reference voltage and the variable voltage is a measure of the magnetic bearing of the receiver from the omni-range station. This is illustrated in figure 4-2 for aircraft positions A through H. Thus the receiver can give omni-bearing indications by measuring the phase angle between the reference and variable phase voltages. Further, the receiver could give course deviation indications from any omni-bearing line selected by comparing the variable phase voltage with the reference phase voltage when the latter has been shifted an amount corresponding to the selected omni-bearing line. How this is done is explained in paragraph 4-5 below.

4-4. OMNI-BEARING DETERMINATION.

It was pointed out above and illustrated in figure 4-2 that the phase angle between the reference phase voltage and the variable phase voltage is a measure of the bearing of the receiver

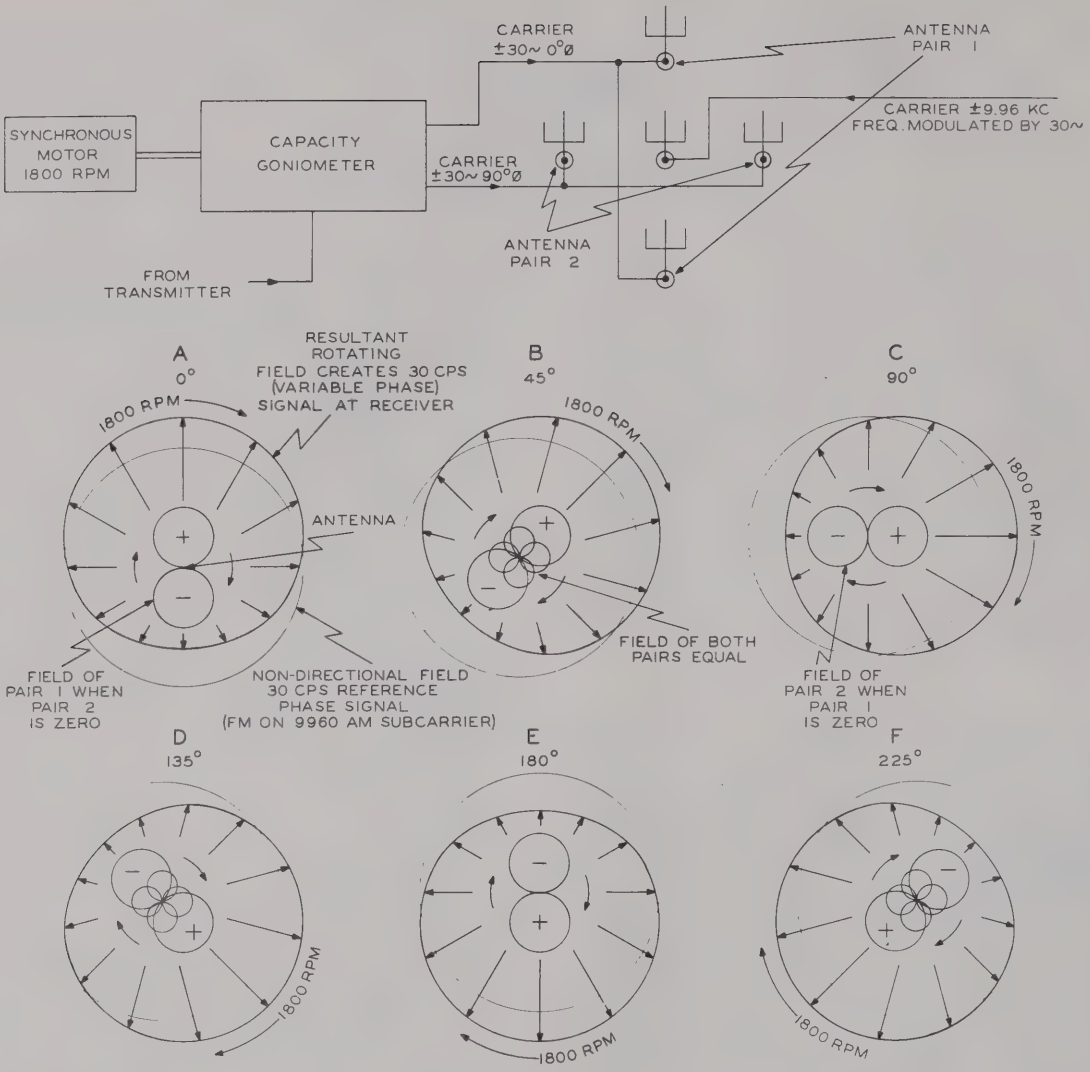

CARRIER
±30~ 0°Ø
ANTENNA PAIR 1
CARRIER ±9.96 KC
FREQ. MODULATED BY 30~
SYNCHRONOUS MOTOR 1800 RPM
CAPACITY GONIOMETER
CARRIER
±30~ 90°Ø
ANTENNA PAIR 2
FROM TRANSMITTER
A
0°
RESULTANT ROTATING FIELD CREATES 30 CPS (VARIABLE PHASE) SIGNAL AT RECEIVER
B
45°
C
90°
1800 RPM
ANTENNA
+
−
FIELD OF BOTH PAIRS EQUAL
FIELD OF PAIR 1 WHEN PAIR 2 IS ZERO
NON-DIRECTIONAL FIELD 30 CPS REFERENCE PHASE SIGNAL (FM ON 9960 AM SUBCARRIER)
FIELD OF PAIR 2 WHEN PAIR 1 IS ZERO
D
135°
E
180°
F
225°

Figure 4-1 Omni-Range Radiation System

from the omni-range station. In order to be useful the receiver must determine this phase angle difference very accurately. If it were practical to determine when two voltages were exactly in phase, this phase angle difference could be measured by shifting the phase of the reference phase voltage until the reference and variable phase voltages were exactly in phase. (See figure 4-3 A, B.) Then the amount the reference phase voltage was shifted would be a measure of the omni-bearing and could be indicated on any convenient scale or dial linked to the shaft of the phase shifting device. Because it is very difficult to determine when two voltages are exactly in phase and it is comparatively simple to determine when two voltages have an exact 90° phase relationship, the reference phase voltage is shifted an amount equal to the variable phase voltage plus 90°. This voltage is referred to as the shifted reference phase voltage, "R", and is illustrated in figures 4-3C and 4-4. A phase comparator circuit is used to indicate this quadrature relationship between the shifted reference phase and variable phase voltages. The circuit operates the vertical pointer meter movement on the deviation indicator, centering the pointer when a quadrature relationship exists between the shifted reference phase and variable phase voltages. A counter type dial (MAGNETIC BEARING indicator on OBS) indicating the shift in reference phase voltage is attached to the shaft of the phase shifting device in

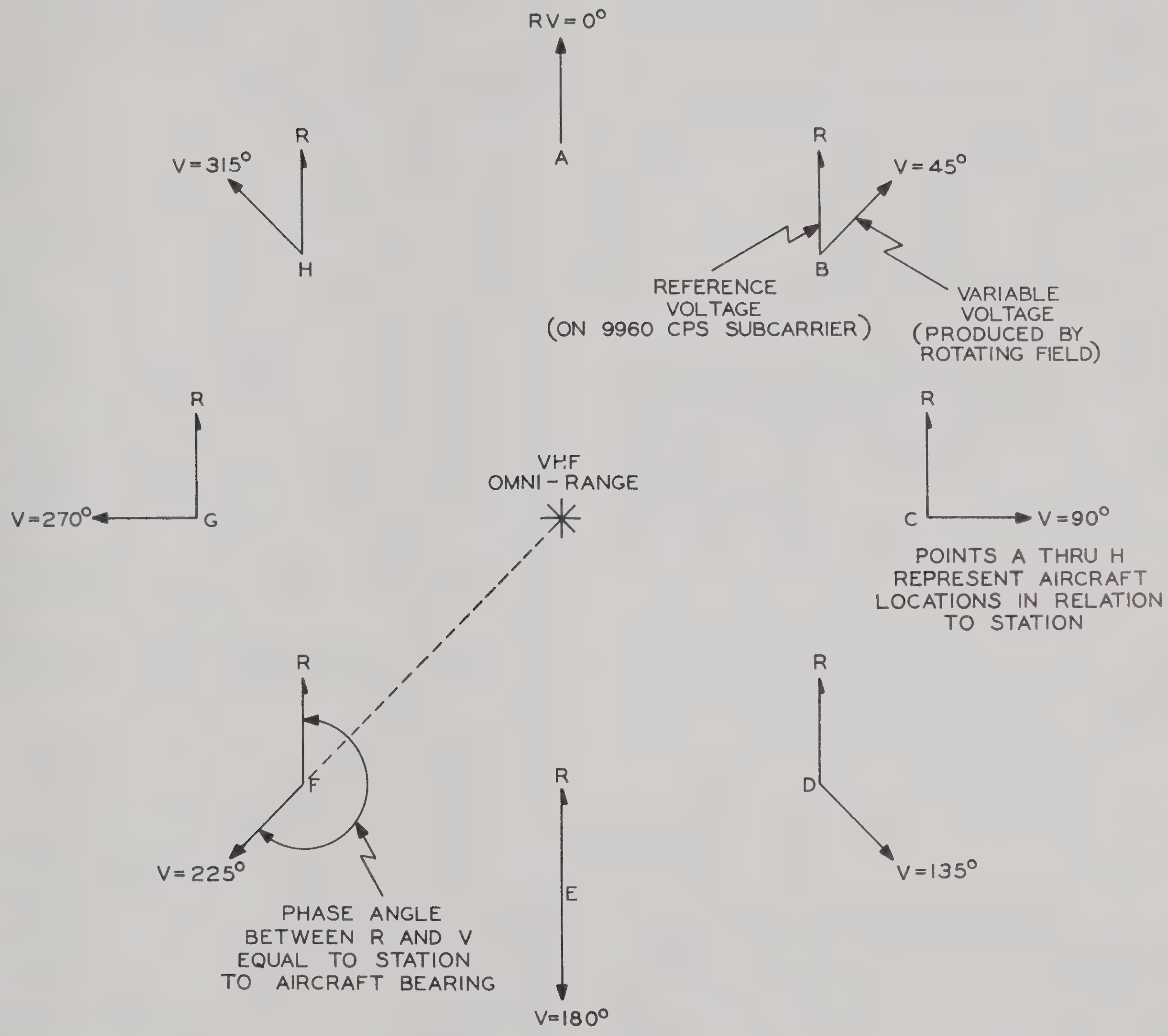

RV = 0°
A
R
V = 315°
H
R
V = 45°
B
REFERENCE VOLTAGE (ON 9960 CPS SUBCARRIER)
VARIABLE VOLTAGE (PRODUCED BY ROTATING FIELD)
R
V = 270°
G
VHF OMNI – RANGE
R
C
V = 90°
POINTS A THRU H REPRESENT AIRCRAFT LOCATIONS IN RELATION TO STATION
R
F
V = 225°
PHASE ANGLE BETWEEN R AND V EQUAL TO STATION TO AIRCRAFT BEARING
R
E
V = 180°
R
D
V = 135°

Figure 4-2 Omni-Range Phase Relations

such a position that the extra 90° of phase shift is not indicated on its scale. Thus when the operator adjusts the phase shifter (selector knob on OBS) for a 90° phase relationship in the phase comparator circuit the dial (MAGNETIC BEARING indication on OBS) on the phase shifter indicates the omni-bearing of the receiver, not the omni-bearing plus 90°. Note R' in figure 4-4.

4-5. COURSE DEVIATION INDICATIONS.

When the omni-bearing is the same as the dial (MAGNETIC BEARING indication on the OBS) reading on the manually operated phase shifter, a 90° phase relationship exists between the shifted reference phase voltage, R'', and the variable phase voltage, V. Under these conditions the

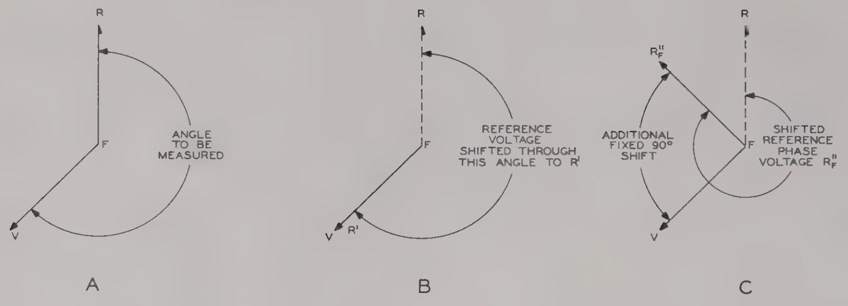

R
F
V
ANGLE TO BE MEASURED
A
R
F
V
R'
REFERENCE VOLTAGE SHIFTED THROUGH THIS ANGLE TO R'
B
R
R''_F
F
V
ADDITIONAL FIXED 90° SHIFT
SHIFTED REFERENCE PHASE VOLTAGE R''_F
C

Figure 4-3. Diagram of VOR Phase Shift Requirements

vertical needle of the deviation indicator is centered. If the aircraft deviates from the selected omni-bearing line, the omni-bearing of the aircraft changes and the 90° phase relationship in the phase comparator circuit no longer exists because the phase of the variable phase voltage has changed. The amount and direction of this change is measured by the phase comparator and indicated on the vertical needle of the deviation indicator as course deviation.

4-6. TO-FROM INDICATIONS.

Refer to figure 4-5. The phase relationships existing for an aircraft flying from B to F on an omni-bearing line of 225° are shown for the two conditions of flying TO the station and away FROM the station. Note that the required 90° phase relation between the shifted reference phase voltage R''_B and the variable phase voltage V_B, exists in both the TO and FROM conditions, the only difference being that the variable phase voltage lags the shifted reference phase voltage while flying TO the station and it leads the shifted reference phase voltage while flying FROM the station. This suggests a method of providing the pilot with bearing sensing or TO-FROM indications. All that is necessary is a device that will indicate the relative 90° lead or lag of the variable and shifted reference phase voltages as TO and FROM indications.

The phase comparator, by itself, cannot distinguish between the two possible conditions of R'' leading V by 90° or of R'' lagging V by 90°. To resolve this ambiguity another 90° fixed phase shift is added to the shifted reference phase voltage, R''. See R'' figure 4-5. Then the new shifted reference phase voltage, R'', (applied to the TO-FROM phase comparator) is either in phase or 180° out of phase with the variable phase voltage. A TO-FROM phase comparator determines whether the new shifted reference phase voltage, R'', is in or out of phase with the variable phase voltage. This phase comparator operates the TO-FROM indicator to show FROM when R'' is in phase with the variable voltage and TO when R'' is out of phase with the variable voltage.

4-7. AUTOMATIC OMNI-BEARING INDICATIONS.

The manner in which omni-bearing is determined manually was discussed above. This, in principle, consisted of centering the vertical needle of the deviation indicator by shifting the phase of the reference phase voltage and reading the required phase shift as the omni-bearing. On the equipment this consists of turning the OBS knob until the vertical needle of the deviation indicator centers and the TO-FROM indication is TO. The omni-bearing is then indicated in the OBS MAGNETIC BEARING window. This same process is performed by a servo system to give automatic and continuous omni-bearing indications on the OBI and, with the addition of magnetic heading information, on the RMI. An analogy to the manual omni-bearing determining system would be that of an extra crew member who continually changed the OBS setting in the proper direction and amount to keep the vertical needle centered and the TO-FROM indication TO. The OBS indication would then be the omni-bearing as presented on the OBI and RMI by the automatic system. To understand the operation of the automatic omni-bearing determining system refer to figure 4-6. The automatic phase shifter (resolver), its drive motor, the automatic phase comparator, and balanced modulator form a servo loop whose input quantity is the variable phase voltage and whose output quantity is shaft rotation corresponding to the omni-bearing. If the omni-bearing indication on the OBI dial is not correct the reference phase voltage has not been shifted by the automatic phase shifter the proper amount to give an in-phase, or null condition in the automatic phase comparator. The phase comparator detects this unbalance as an error signal and feeds it to the balanced modulator. The balanced modulator, in turn, operates the two phase motor which drives the automatic phase shifter around to the position corresponding to an in-phase, balanced, or no signal condition. Since the OBI dial is linked to the shaft of the automatic phase shifter it rotates when the aircraft changes its omni-bearing and indicates the omni-bearing continuously.

4-8. HEADING INDICATIONS.

Compass heading information determined by the Fluxgate or Gyrosyn compass system is transmitted to the azimuth card of the RMI by the use of a synchro generator, control transformer, servo amplifier and two phase induction motor. See figure 4-7. The synchro generator, a part of the Fluxgate or Gyrosyn system, has a single rotor winding and three stator windings placed 120 degrees apart. The rotor shaft is positioned to the aircrafts magnetic heading by the elements of the compass that establish direction. A source of 26 volts, 400 cps is connected to the rotor winding through two slip rings. The rotor, being a salient pole type sets up a flux that induces a voltage in each of the three stator windings. The magnitude and phase of each of these three voltages depends upon the position of the rotor; ie, the compass heading. When the rotor is perpendicular to one winding of the stator, as in part A, no voltage is induced in that stator winding, but voltages equal in magnitude and opposite in phase (to each other) are induced in the other two stator windings. When the rotor is parallel to one winding of the stator, as in part B, maximum voltage is induced in that stator winding and voltages equal in magnitude and alike in phase are induced in the other two stator windings. Thus, a set of three single phase voltages is formed containing all of the positional information of the rotor. That is, for each position of the rotor there exists a certain set of three voltage magnitude and phase conditions that is peculiar to that position only.

The three stator windings of the compass data synchro generator are connected to the three

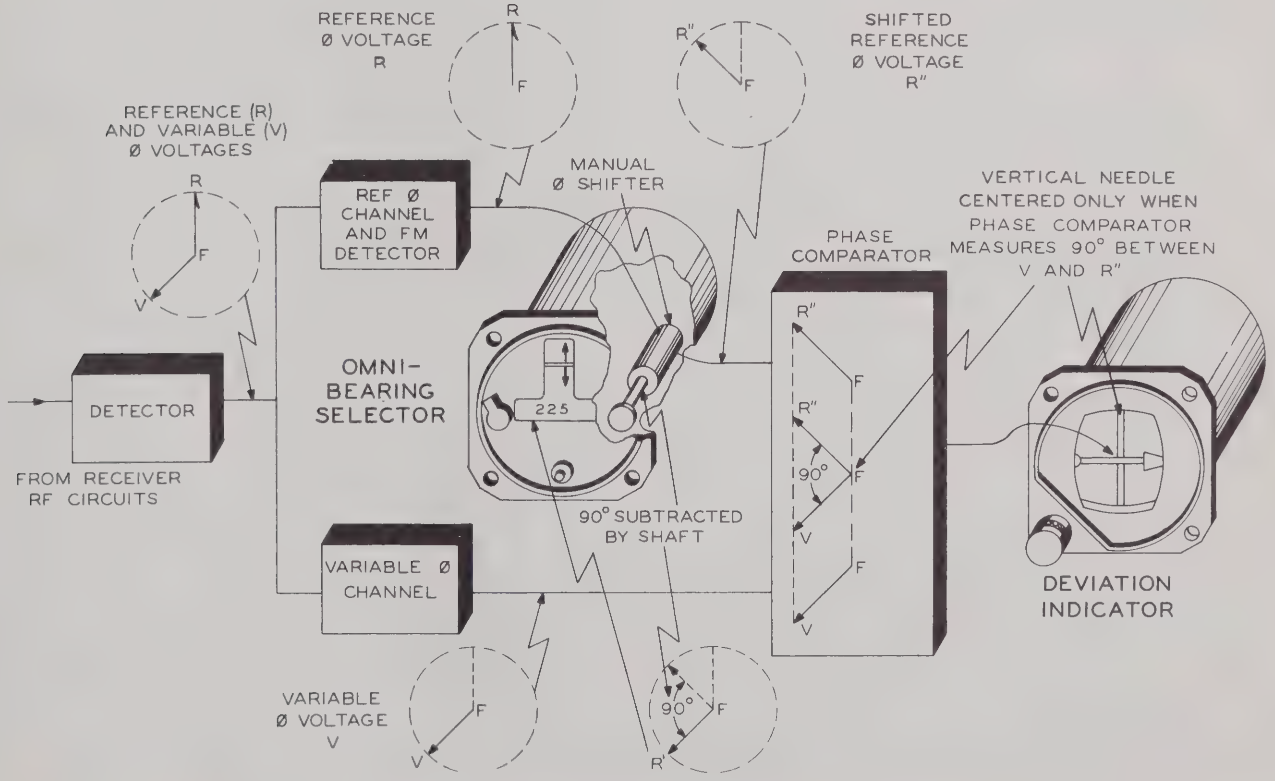

REFERENCE Ø VOLTAGE R
R
F
R''
F
SHIFTED REFERENCE Ø VOLTAGE R''
REFERENCE (R) AND VARIABLE (V) Ø VOLTAGES
R
F
V
REF Ø CHANNEL AND FM DETECTOR
MANUAL Ø SHIFTER
VERTICAL NEEDLE CENTERED ONLY WHEN PHASE COMPARATOR MEASURES 90° BETWEEN V AND R''
PHASE COMPARATOR
DETECTOR
OMNI-BEARING SELECTOR
225
R''
F
R''
90°
F
V
F
V
FROM RECEIVER RF CIRCUITS
90° SUBTRACTED BY SHAFT
VARIABLE Ø CHANNEL
DEVIATION INDICATOR
VARIABLE Ø VOLTAGE V
F
V
90°
F
R'

Figure 4-4. Block Diagram of Manual Phase Comparison System

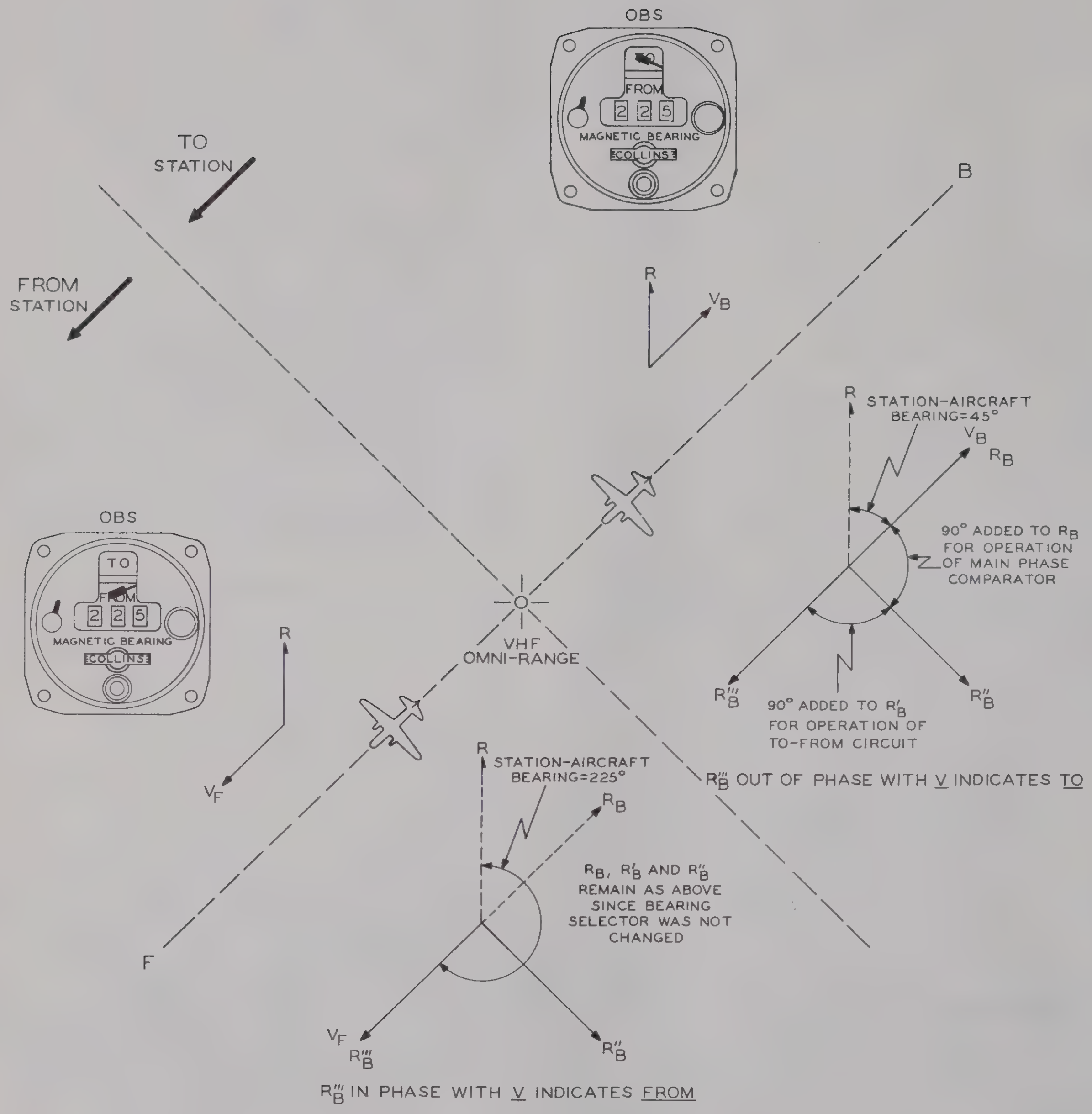

OBS
TO
FROM
2 2 5
MAGNETIC BEARING
COLLINS
TO STATION
FROM STATION
B
R
V_B
R
STATION-AIRCRAFT BEARING=45°
V_B
R_B
90° ADDED TO R_B FOR OPERATION OF MAIN PHASE COMPARATOR
OBS
TO
FROM
2 2 5
MAGNETIC BEARING
COLLINS
R
VHF OMNI-RANGE
R_B'''
90° ADDED TO R_B' FOR OPERATION OF TO-FROM CIRCUIT
R_B''
V_F
R
STATION-AIRCRAFT BEARING=225°
R_B
R_B''' OUT OF PHASE WITH $\underline{V}$ INDICATES TO
R_B, R_B' AND R_B'' REMAIN AS ABOVE SINCE BEARING SELECTOR WAS NOT CHANGED
F
V_F
R_B'''
R_B''
R_B''' IN PHASE WITH $\underline{V}$ INDICATES FROM

Figure 4-5. Phase Relations in TO-FROM Indicator Operation

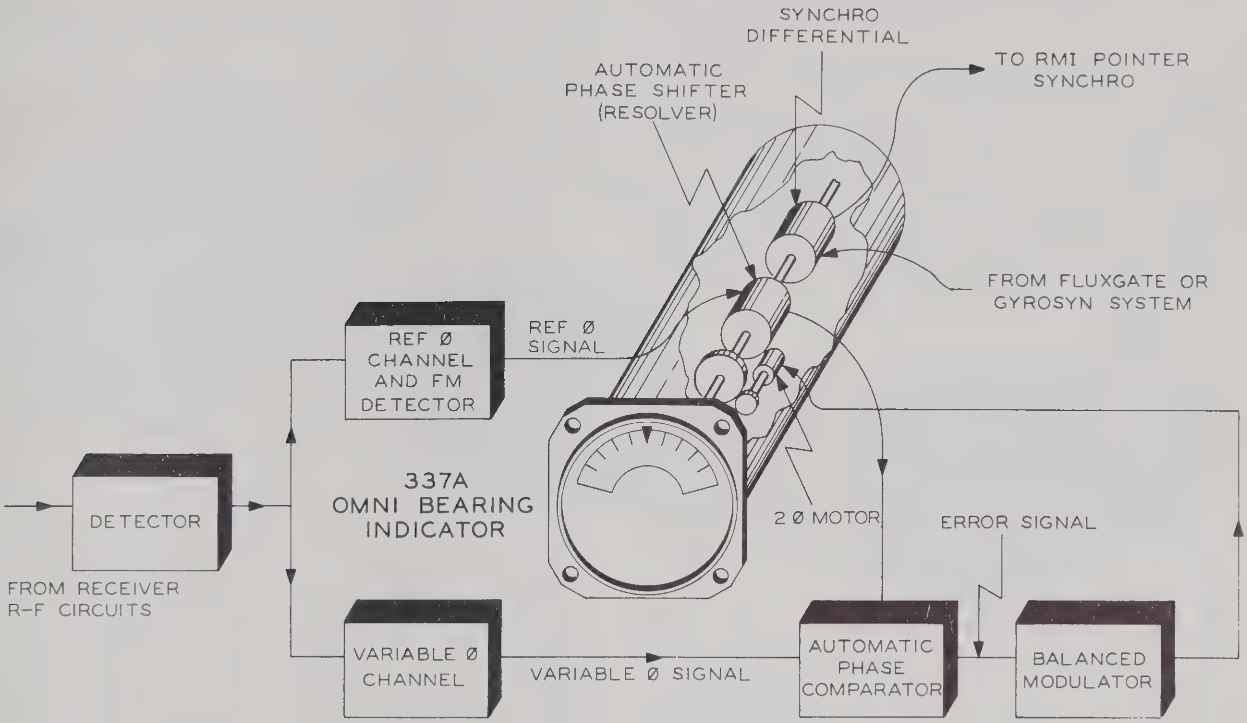

SYNCHRO DIFFERENTIAL
AUTOMATIC PHASE SHIFTER (RESOLVER)
TO RMI POINTER SYNCHRO
FROM FLUXGATE OR GYROSYN SYSTEM
REF Ø CHANNEL AND FM DETECTOR
REF Ø SIGNAL
DETECTOR
FROM RECEIVER R-F CIRCUITS
337A OMNI BEARING INDICATOR
2 Ø MOTOR
ERROR SIGNAL
VARIABLE Ø CHANNEL
VARIABLE Ø SIGNAL
AUTOMATIC PHASE COMPARATOR
BALANCED MODULATOR

Figure 4-6. Block Diagram of OBI Servo System

stator windings of the azimuth card synchro control transformer in the RMI. The control transformer is similar to the synchro generator except that its rotor is cylindrical instead of salient pole, and has a single high impedance winding consisting of a large number of turns of very fine wire placed in skewed slots. The three single phase voltages applied to the three stator windings of the control transformer set up a flux that is oriented with respect to the stator exactly as the flux in the synchro generator is oriented with respect to its stator. Maximum voltage is induced in the control transformer rotor when the rotor is parallel to this flux. No voltage is induced in the rotor when the rotor is perpendicular to the flux. When the rotor is displaced clockwise from the perpendicular or no voltage position the voltage induced in its winding is opposite in phase to that induced when the rotor is displaced counterclockwise from the no voltage position. Thus an error voltage is obtained from the rotor having a magnitude and phase depending on the amount and direction, respectively, of the rotor displacement from zero voltage position. This error voltage is applied to the 333B-1 servo amplifier where it is used to control the speed and direction of the two phase induction motor. The two phase motor drives both the azimuth card and the rotor of the azimuth card control transformer.

When a change in heading takes place an error voltage is induced in the rotor of the control transformer and applied to the servo amplifier. The servo amplifier, in turn, controls the power to the two phase motor to cause it to rotate the rotor of the control transformer to the null or no voltage position corresponding to the new heading. The azimuth card, being geared to the motor and control transformer rotor, follows the change in heading degree for degree to indicate the heading at all times. A detailed explaination of how the 333B-1 Servo Amplifier controls the power to the two phase induction motor follows below.

4-9. RMI SERVO AMPLIFIER.

As explained above, the function of the 333B-1 servo amplifier is to control the speed and direction of the two phase azimuth card motor in accordance with the error voltage applied to it from the rotor of the azimuth card control transformer. See figure 4-8. Error voltage from the control transformer rotor is applied to the grids of V-601A and V-601B through T-601. Two secondary windings are used to obtain grid voltages 180 degrees out of phase. T-603 supplies an a-c voltage to the plates of V-601A and V-601B through the primary windings of saturable reactor T-602. Since the Fluxgate or Gyrosyn compass system and T-602 have a common a-c source the error voltage at the grid of V-601A will always be either in phase with or 180 degrees out of phase with the reference plate voltage from T-603.

Consider first the case when the error voltage is in phase with the reference plate voltages. At the instant when the plate voltages are maximum positive the voltage at the grid of V-601A is maximum positive and the voltage at the grid of V-601B is maximum negative. Plate current will flow through V-601A and the primary winding of saturable reactor T-602A since the grid of V-601A is positive, but no current (or relatively little current) will flow through the primary winding of T-602B because V-601B will be at (or near) cut-off due to the negative voltage on its grid. During the next half cycle when the reference plate voltage, E_1, is negative no current flows in either triode. A d-c pulsating (half-wave) current flows in the primary of T-602A when the input error voltage is in phase with the reference plate voltage. A similar analysis will show that V-601A will be cut off (or nearly so) and a pulsating d-c current will flow in the primary of T-602B when the input error voltage is 180 degrees out of phase with the reference plate voltage.

Both windings of the two phase motor are connected to a source of 26 volts, 400 cps through the high impedance secondary windings of saturable reactor T-602. The voltages applied to the two stator windings of the motor must be 90 degrees apart. This 90 degree required phase shift is accomplished by connecting phase shifting capacitor C-605 in series with one of the windings. The current through this winding then leads the voltage by some angle less than 90 degrees while the current through the other winding lags by an angle less than 90 degrees because of the reactance of the winding. The value of C-605 is chosen to make the current in the two windings nearly 90 degrees apart. Current in the two stator windings causes a flux to rotate, cutting short circuited rotor windings. This causes a torque and rotation of the rotor in the same direction as the rotating flux but at a speed less than that of the flux. The direction of rotation

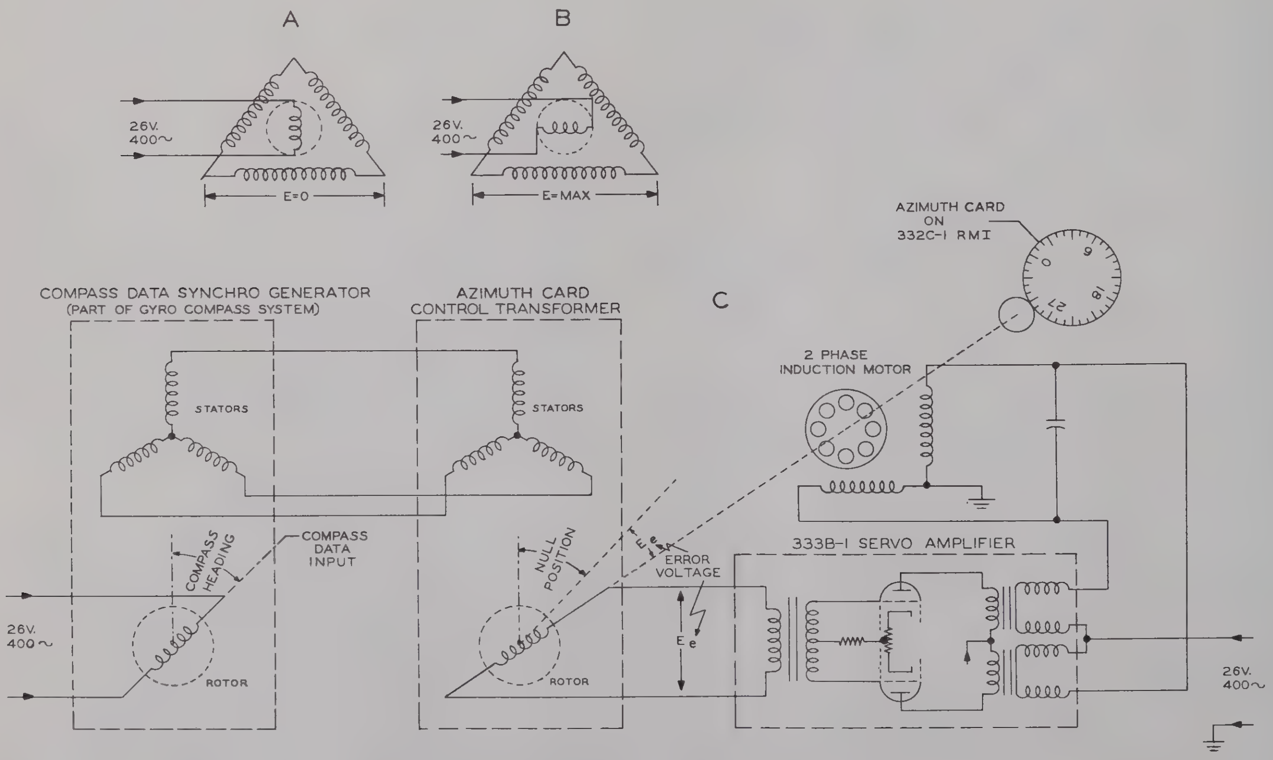
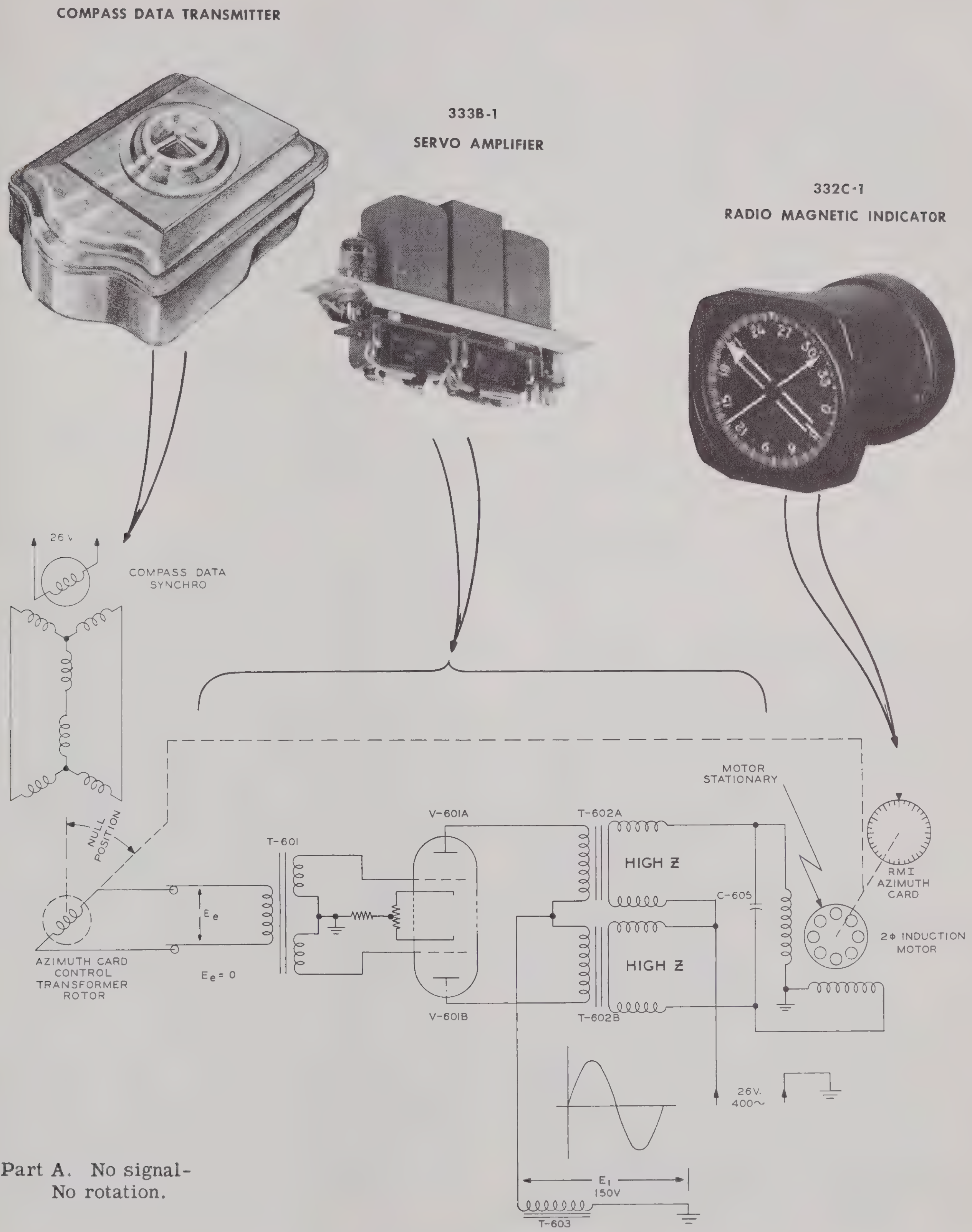
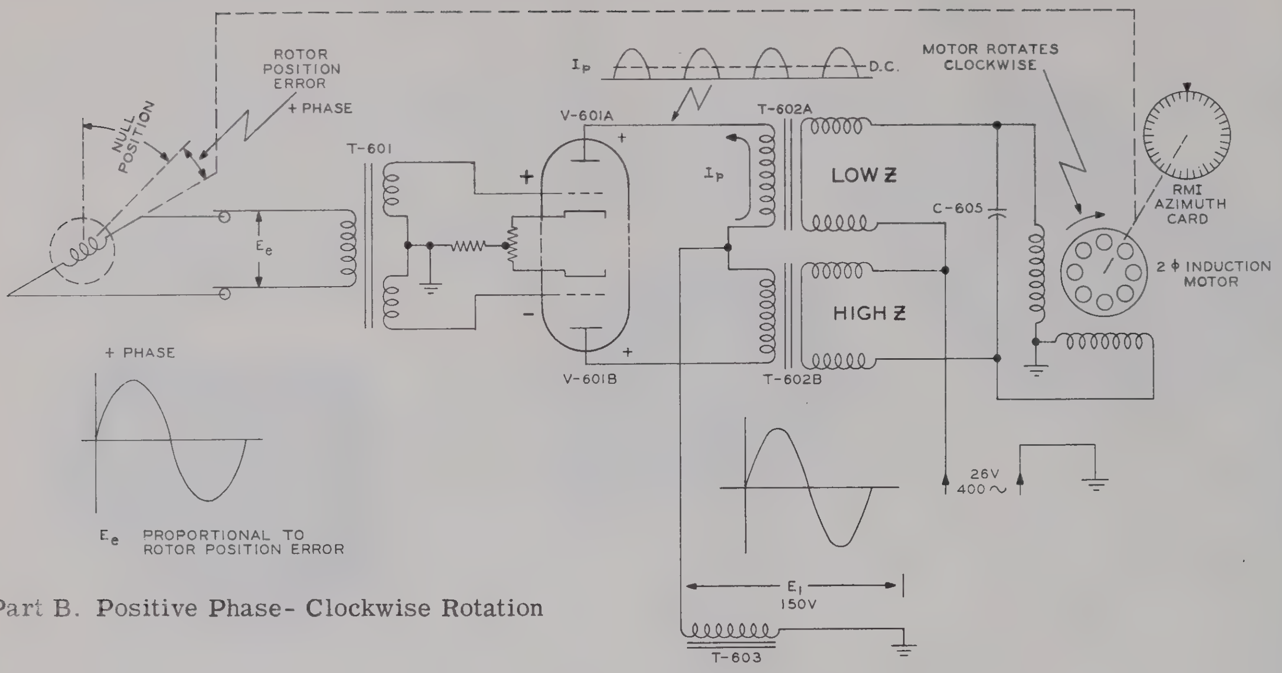

A
B
26V.
400~
E=0
26V.
400~
E=MAX
AZIMUTH CARD
ON
332C-1 RMI
0
9
18
27
COMPASS DATA SYNCHRO GENERATOR
(PART OF GYRO COMPASS SYSTEM)
AZIMUTH CARD
CONTROL TRANSFORMER
C
STATORS
STATORS
2 PHASE
INDUCTION MOTOR
COMPASS HEADING
COMPASS
DATA
INPUT
NULL POSITION
Ee
ERROR
VOLTAGE
333B-1 SERVO AMPLIFIER
26V.
400~
ROTOR
ROTOR
Ee
26V.
400~

Figure 4-7. Diagram of Heading and Omni-Bearing Instrumentation

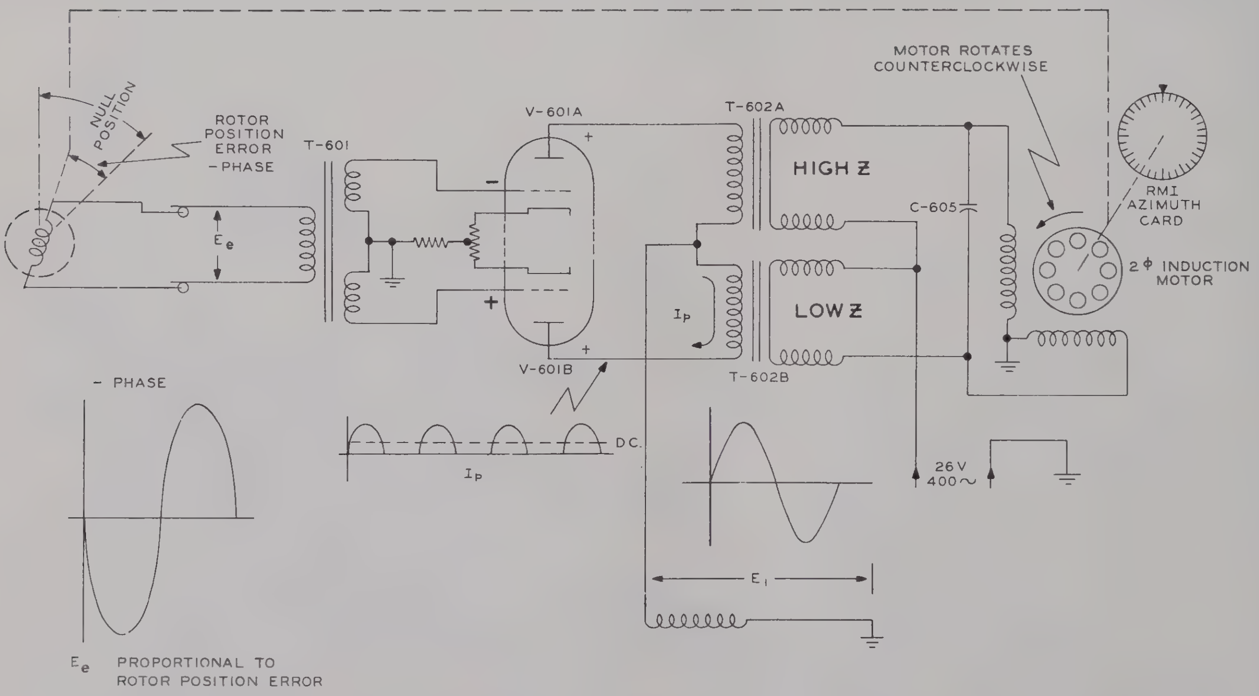

COMPASS DATA TRANSMITTER
333B-1
SERVO AMPLIFIER
332C-1
RADIO MAGNETIC INDICATOR
26 V
COMPASS DATA SYNCHRO
NULL POSITION
AZIMUTH CARD CONTROL TRANSFORMER ROTOR
E_e
$E_e = 0$
T-601
V-601A
V-601B
T-602A
T-602B
HIGH Z
HIGH Z
C-605
MOTOR STATIONARY
RMI AZIMUTH CARD
2Φ INDUCTION MOTOR
26V. 400~
E_1 150V
T-603

Part A. No signal-
No rotation.

Figure 4-8A. Heading Repeating System.


ROTOR POSITION ERROR
+ PHASE
NULL POSITION
T-601
E_e
Ip
D.C.
V-601A
V-601B
T-602A
T-602B
Ip
LOW Z
HIGH Z
C-605
MOTOR ROTATES CLOCKWISE
RMI AZIMUTH CARD
2 Φ INDUCTION MOTOR
26V 400 ~
+ PHASE
E_e PROPORTIONAL TO ROTOR POSITION ERROR
E_1
150V
T-603

Part B. Positive Phase- Clockwise Rotation


NULL POSITION
ROTOR POSITION ERROR
- PHASE
T-601
E_e
V-601A
V-601B
T-602A
T-602B
HIGH Z
LOW Z
Ip
C-605
MOTOR ROTATES COUNTERCLOCKWISE
RMI AZIMUTH CARD
2 Φ INDUCTION MOTOR
26V 400 ~
- PHASE
D.C.
Ip
E_1
E_e PROPORTIONAL TO ROTOR POSITION ERROR

Part C. Negative Phase-Counterclockwise Rotation

Figure 4-8. B. C. Heading Repeating System

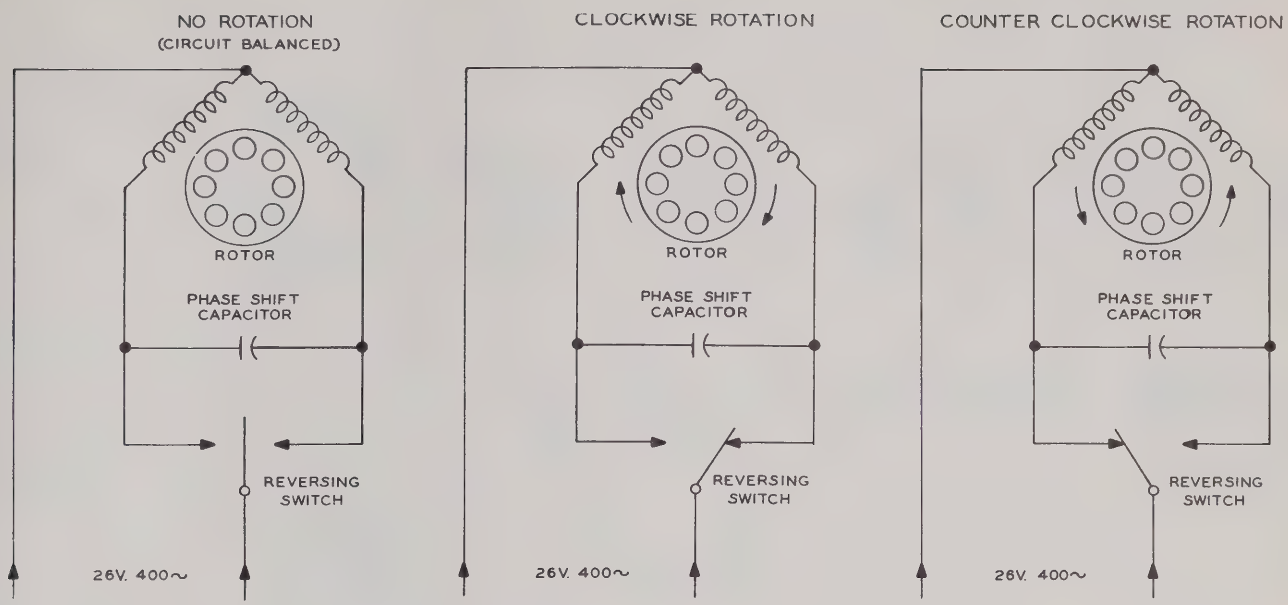


Figure 4-9. Servo Motor Reversing Circuit

of the flux, hence the rotor, can be changed by reversing the connections to either stator winding. Figure 4-9 shows a simple switch arrangement to reverse connections and direction of rotation. Saturable reactor T-602 takes the place of the reversing switch shown in figure 4-9. Under conditions of no-error-voltage the impedances of T-602A and B secondary control windings are equal, the system is balanced and the motor does not run. The high impedance of the secondary control windings of T-602A or B can be reduced by passage of d-c plate current through the primary windings. When an error voltage is present, d-c plate current flows through the primary of T-602A or B depending on the phase of the error voltage, and the high impedance of the secondary control windings of T-602A or B is reduced. Reduction in secondary impedance of either T-602A or B causes unbalance of the 26 volts applied to the two phase motor and rotation of the motor. Figure 4-8 A, B and C shows conditions for no error-voltage no-rotation, 0 degree error-voltage clockwise rotation, and 180 degrees error-voltage counter-clockwise rotation. In addition to the direction control provided by the servo amplifier it should be remembered that speed control is attained to some degree in that the torque is proportional to the amount of unbalance in the motor control circuit which, in turn, is proportional to the magnitude of the error voltage.

RADIO SECTION.

4-10. INTRODUCTION.

The manner in which the composite signal recovered from the r-f carrier at the detector is used to perform all the required navigation functions of the system was discussed above. It was seen that the necessary omni-bearing information recovered from the r-f carrier and audio subcarrier is in the form of a 30 cps reference phase signal and another 30 cps variable phase signal whose phase differs from that of the reference phase signal by an amount corresponding exactly to the omni-bearing. The 30 cps reference phase signal is transmitted and received as 30 cps frequency modulation on a 9960 cps subcarrier. The 9960 subcarrier is transmitted as 30% amplitude modulation on the omni-range vhf carrier. The 30 cps variable phase signal is effectively received as 30% amplitude modulation on the omni-range vhf carrier. A rather elaborate radio receiving system is necessary to select, amplify, and demodulate the omni-range vhf signal that carries the two 30 cps signals. It must have high sensitivity, selectivity and rejection to unwanted signals as well as a very accurate gang tuning system for rapid finger-tip selection of any one of 280 frequency channels. The 51R-3 receiver meets these requirements by the use of a double

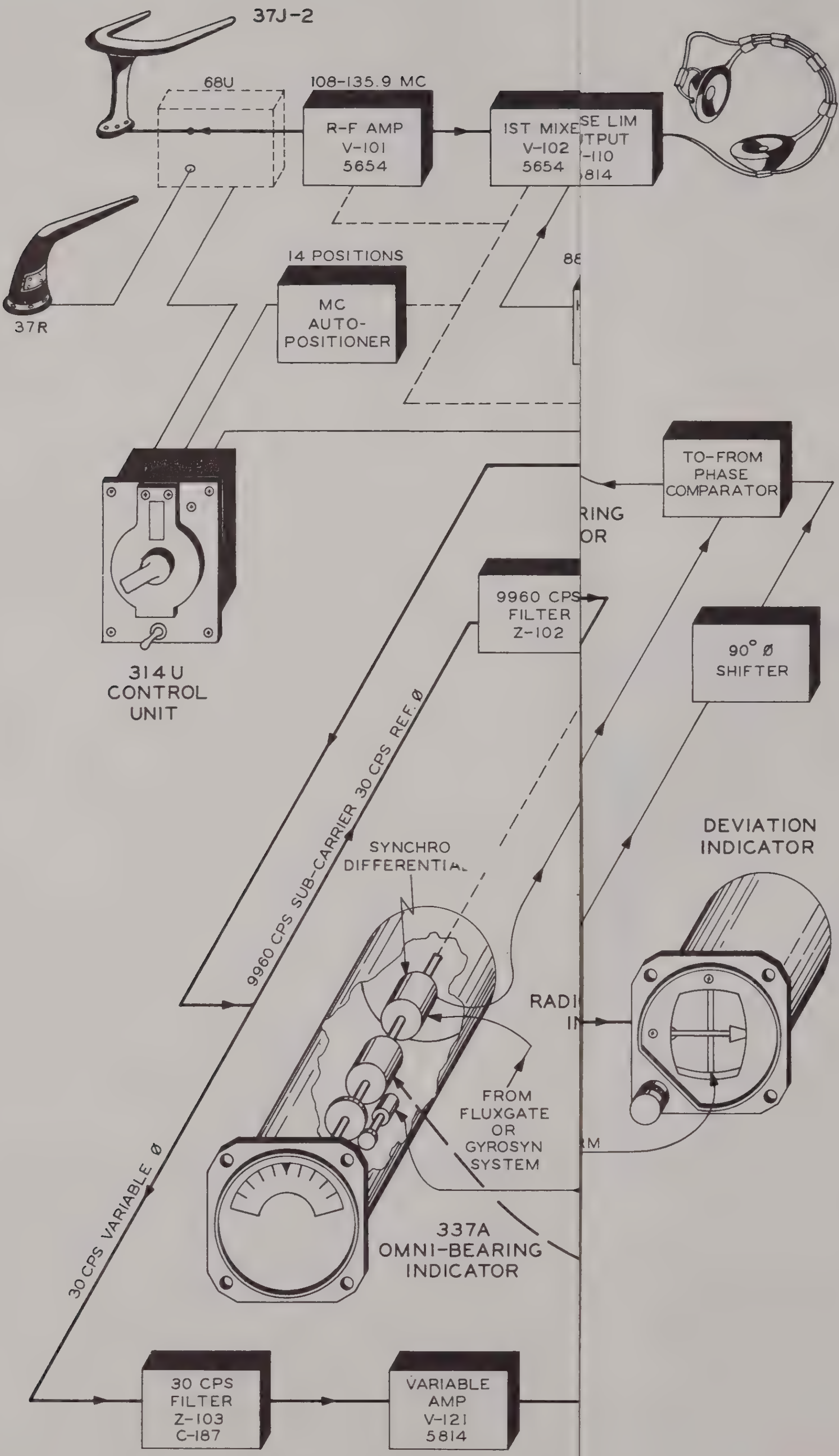

37J-2
68U
108-135.9 MC
R-F AMP
V-101
5654
IST MIXE
V-102
5654
SE LIM
TPUT
-110
814
14 POSITIONS
MC
AUTO-
POSITIONER
88
37R
TO-FROM
PHASE
COMPARATOR
RING
OR
314 U
CONTROL
UNIT
9960 CPS
FILTER
Z-102
90° Ø
SHIFTER
9960 CPS SUB-CARRIER 30 CPS REF. Ø
SYNCHRO
DIFFERENTIAL
DEVIATION
INDICATOR
RADI
IN
FROM
FLUXGATE
OR
GYROSYN
SYSTEM
RM
337A
OMNI-BEARING
INDICATOR
30 CPS VARIABLE Ø
30 CPS
FILTER
Z-103
C-187
VARIABLE
AMP
V-121
5814

Figure 4-10. Block Diagram of 51R-3 Or

conversion crystal controlled superheterodyne circuit tuned by the remote controlled Autopositioner.

4-11. ANTENNA SYSTEM.

The 37J Antenna is designed to receive horizontally polarized omni-range and localizer signals in the 108 to 122 mc range. The 37R antenna is designed to handle vertically polarized voice communications in the 122 to 136 mc range. It is therefore necessary to change antennas when switching from navigation channels to communication channels. The necessary antenna switching is accomplished automatically by an antenna change-over relay, Collins Type 68U-1, when the 314U Frequency Selector is changed from 121.9 to 122 mc. Communication transmissions in the 118 to 122 mc range are spherically polarized but since the 37J-2 antenna receives spherically polarized waves no extra switching is required.

4-12. FREQUENCY CONVERSION SYSTEM.

Refer to the system block diagram, figure 4-10. The signals picked up on the antenna are fed to an r-f amplifier whose grid and plate tuned circuits pass a two megacycle band of frequencies and cover the entire frequency range 108.0 to 135.9 mc in 14 increments. In the following 1st mixer the desired signal is hererodyned down to a variable intermediate frequency in the range 19.45 to 21.35 mc by an injection voltage from the h-f oscillator-amplifier. The injection voltage from the h-f oscillator-amplifier is obtained by doubling signals from a crystal oscillator in which 14 crystals are switched by the megacycle autopositioner to obtain any one of 14 oscillator output signals in the range 44.275 to 57.275 mc. The h-f oscillator crystal selector switch, the tuning slugs for four tuned circuits in the h-f oscillator amplifier and three tuned circuits in the r-f amplifier are mechanically positioned by the megacycle Autopositioner. Output of the first mixer is fed to the variable i-f amplifier. The variable i-f amplifier is tuned by the tenth megacycle autopositioner from 19.45 to 21.35 mc in tenth megacycle steps. See table 4-1. The desired signal in the 19.45 through 21.35 mc range applied to the 2nd mixer is heterodyned down to a fixed i-f of 3.15 mc by an injection voltage from the L-F oscillator. The frequency of the L-F oscillator is controlled by any one of 20 crystals selected by the tenth megacycle Autopositioner. The crystal frequency in the range 8.15 through 9.1 mc is doubled in the oscillator and applied to the 2nd mixer through a double tuned circuit. The L-F oscillator crystal selector switch and tuning slugs for the variable i-f amplifier, 2nd mixer, and L-F oscillator tuned circuits are all mechanically positioned by the tenth megacycle Autopositioner. Because crystal selection and tuning of second conversion circuits are ganged, L-F oscillator injection frequencies that will result in a 3.15 mc i-f are always selected. See Table 4-1. The 3.15 mc fixed i-f signal is amplified by three fixed i-f amplifiers and applied to the detector.

Table 4-1 shows how the double conversion system operates to obtain the 3.15 mc signal for application to the fixed i-f amplifier. The table could be completed to give the same information for received frequencies up through 135.9 mc. As will be noted in the table, the r-f circuits pass a 2 mc band of frequencies for each position of the megacycle Autopositioner. The frequency of the injection voltage for the 1st mixer is the same for the 20 positions of the one-tenth megacycle Autopositioner but changes with the operation of the megacycle Autopositioner. The frequency of the variable i-f is different for each position of the one-tenth megacycle Autopositioner. The frequency of the 2nd mixer injection voltage is varied in the range 16.3 through 18.2 mc for each position of the one-tenth megacycle Autopositioner. As a result the fixed i-f is always 3.15 mc.

Table 4-1.

Channel Selector Position		Frequency of Received Signal	Frequency Band Passed by R-F Amplifier	Frequency of			
MC	.1 MC			1st Mixer Inj. Signal	Variable I-F Amplifier	2nd Mixer Inj. Signal	Fixed I-F Amplifier
108	0.0	108.0 mc	108.0 to 110.0	88.55 mc	19.45 mc	16.3 mc	3.15 mc
	0.1	108.1	108.0 to 110.0	88.55	19.55	16.4	3.15
	0.2	108.2	108.0 to 110.0	88.55	19.65	16.5	3.15
	0.3	108.3	108.0 to 110.0	88.55	19.75	16.6	3.15
	0.4	108.4	108.0 to 110.0	88.55	19.85	16.7	3.15

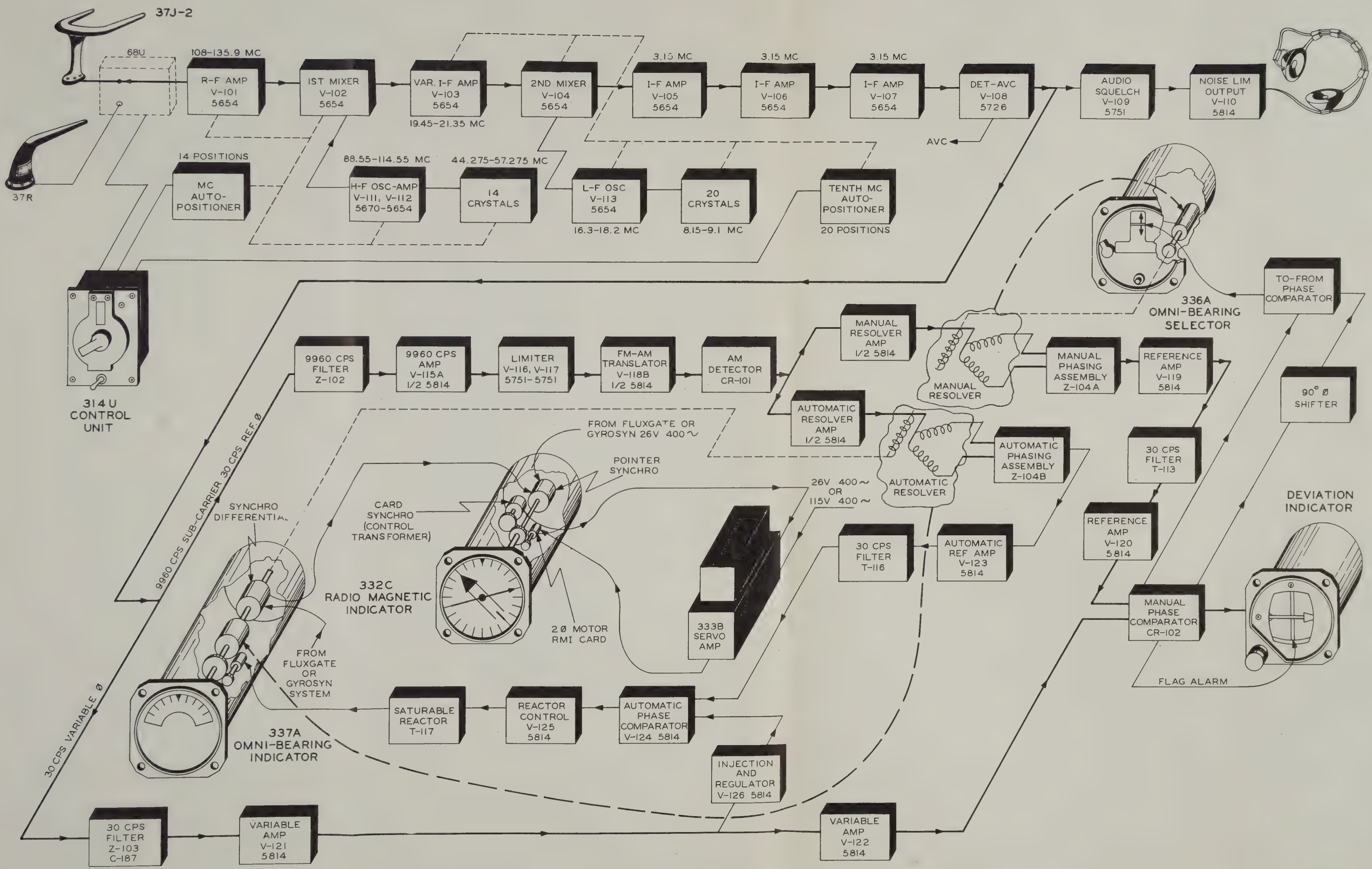

37J-2
68U
108-135.9 MC
R-F AMP V-101 5654
IST MIXER V-102 5654
VAR. I-F AMP V-103 5654
19.45-21.35 MC
2ND MIXER V-104 5654
3.15 MC
I-F AMP V-105 5654
3.15 MC
I-F AMP V-106 5654
3.15 MC
I-F AMP V-107 5654
DET-AVC V-108 5726
AVC
AUDIO SQUELCH V-109 5751
NOISE LIM OUTPUT V-110 5814
37R
14 POSITIONS
MC AUTO-POSITIONER
88.55-114.55 MC
H-F OSC-AMP V-111, V-112 5670-5654
44.275-57.275 MC
14 CRYSTALS
L-F OSC V-113 5654
16.3-18.2 MC
20 CRYSTALS
8.15-9.1 MC
TENTH MC AUTO-POSITIONER
20 POSITIONS
314U CONTROL UNIT
336A OMNI-BEARING SELECTOR
TO-FROM PHASE COMPARATOR
MANUAL RESOLVER AMP 1/2 5814
MANUAL RESOLVER
MANUAL PHASING ASSEMBLY Z-104A
REFERENCE AMP V-119 5814
90° Ø SHIFTER
9960 CPS FILTER Z-102
9960 CPS AMP V-115A 1/2 5814
LIMITER V-116, V-117 5751-5751
FM-AM TRANSLATOR V-118B 1/2 5814
AM DETECTOR CR-101
AUTOMATIC RESOLVER AMP 1/2 5814
AUTOMATIC RESOLVER
AUTOMATIC PHASING ASSEMBLY Z-104B
30 CPS FILTER T-113
9960 CPS SUB-CARRIER 30 CPS REF Ø
FROM FLUXGATE OR GYROSYN 26V 400~
POINTER SYNCHRO
SYNCHRO DIFFERENTIAL
CARD SYNCHRO (CONTROL TRANSFORMER)
26V 400~ OR 115V 400~
DEVIATION INDICATOR
REFERENCE AMP V-120 5814
30 CPS FILTER T-116
AUTOMATIC REF AMP V-123 5814
332C RADIO MAGNETIC INDICATOR
2 Ø MOTOR RMI CARD
333B SERVO AMP
MANUAL PHASE COMPARATOR CR-102
FROM FLUXGATE OR GYROSYN SYSTEM
FLAG ALARM
337A OMNI-BEARING INDICATOR
SATURABLE REACTOR T-117
REACTOR CONTROL V-125 5814
AUTOMATIC PHASE COMPARATOR V-124 5814
INJECTION AND REGULATOR V-126 5814
30 CPS VARIABLE Ø
30 CPS FILTER Z-103 C-187
VARIABLE AMP V-121 5814
VARIABLE AMP V-122 5814

Figure 4-10. Block Diagram of 51R-3 Omni-Range Operation

conversion crystal controlled superheterodyne circuit tuned by the remote controlled Autopositioner.

4-11. ANTENNA SYSTEM.

The 37J Antenna is designed to receive horizontally polarized omni-range and localizer signals in the 108 to 122 mc range. The 37R antenna is designed to handle vertically polarized voice communications in the 122 to 136 mc range. It is therefore necessary to change antennas when switching from navigation channels to communication channels. The necessary antenna switching is accomplished automatically by an antenna change-over relay, Collins Type 68U-1, when the 314U Frequency Selector is changed from 121.9 to 122 mc. Communication transmissions in the 118 to 122 mc range are spherically polarized but since the 37J-2 antenna receives spherically polarized waves no extra switching is required.

4-12. FREQUENCY CONVERSION SYSTEM.

Refer to the system block diagram, figure 4-10. The signals picked up on the antenna are fed to an r-f amplifier whose grid and plate tuned circuits pass a two megacycle band of frequencies and cover the entire frequency range 108.0 to 135.9 mc in 14 increments. In the following 1st mixer the desired signal is hererodyned down to a variable intermediate frequency in the range 19.45 to 21.35 mc by an injection voltage from the h-f oscillator-amplifier. The injection voltage from the h-f oscillator-amplifier is obtained by doubling signals from a crystal oscillator in which 14 crystals are switched by the megacycle autopositioner to obtain any one of 14 oscillator output signals in the range 44.275 to 57.275 mc. The h-f oscillator crystal selector switch, the tuning slugs for four tuned circuits in the h-f oscillator amplifier and three tuned circuits in the r-f amplifier are mechanically positioned by the megacycle Autopositioner. Output of the first mixer is fed to the variable i-f amplifier. The variable i-f amplifier is tuned by the tenth megacycle autopositioner from 19.45 to 21.35 mc in tenth megacycle steps. See table 4-1. The desired signal in the 19.45 through 21.35 mc range applied to the 2nd mixer is heterodyned down to a fixed i-f of 3.15 mc by an injection voltage from the L-F oscillator. The frequency of the L-F oscillator is controlled by any one of 20 crystals selected by the tenth megacycle Autopositioner. The crystal frequency in the range 8.15 through 9.1 mc is doubled in the oscillator and applied to the 2nd mixer through a double tuned circuit. The L-F oscillator crystal selector switch and tuning slugs for the variable i-f amplifier, 2nd mixer, and L-F oscillator tuned circuits are all mechanically positioned by the tenth megacycle Autopositioner. Because crystal selection and tuning of second conversion circuits are ganged, L-F oscillator injection frequencies that will result in a 3.15 mc i-f are always selected. See Table 4-1. The 3.15 mc fixed i-f signal is amplified by three fixed i-f amplifiers and applied to the detector.

Table 4-1 shows how the double conversion system operates to obtain the 3.15 mc signal for application to the fixed i-f amplifier. The table could be completed to give the same information for received frequencies up through 135.9 mc. As will be noted in the table, the r-f circuits pass a 2 mc band of frequencies for each position of the megacycle Autopositioner. The frequency of the injection voltage for the 1st mixer is the same for the 20 positions of the one-tenth megacycle Autopositioner but changes with the operation of the megacycle Autopositioner. The frequency of the variable i-f is different for each position of the one-tenth megacycle Autopositioner. The frequency of the 2nd mixer injection voltage is varied in the range 16.3 through 18.2 mc for each position of the one-tenth megacycle Autopositioner. As a result the fixed i-f is always 3.15 mc.

Table 4-1.

Channel Selector Position		Frequency of Received Signal	Frequency Band Passed by R-F Amplifier	Frequency of			
MC	.1 MC			1st Mixer Inj. Signal	Variable I-F Amplifier	2nd Mixer Inj. Signal	Fixed I-F Amplifier
108	0.0	108.0 mc	108.0 to 110.0	88.55 mc	19.45 mc	16.3 mc	3.15 mc
	0.1	108.1	108.0 to 110.0	88.55	19.55	16.4	3.15
	0.2	108.2	108.0 to 110.0	88.55	19.65	16.5	3.15
	0.3	108.3	108.0 to 110.0	88.55	19.75	16.6	3.15
	0.4	108.4	108.0 to 110.0	88.55	19.85	16.7	3.15

Table 4-1 (cont.)

Channel Selector Position		Frequency of Received Signal	Frequency Band Passed by R-F Amplifier	Frequency of			
MC	.1 MC			1st Mixer Inj. Signal	Variable I-F Amplifier	2nd Mixer Inj. Signal	Fixed I-F Amplifier
	0.5	108.5	108.0 to 110.0	88.55	19.95	16.8	3.15
	0.6	108.6	108.0 to 110.0	88.55	20.05	16.9	3.15
	0.7	108.7	108.0 to 110.0	88.55	20.15	17.0	3.15
	0.8	108.8	108.0 to 110.0	88.55	20.25	17.1	3.15
	0.9	108.9	108.0 to 110.0	88.55	20.35	17.2	3.15
	1.0	109.0	108.0 to 110.0	88.55	20.45	17.3	3.15
	1.1	109.1	108.0 to 110.0	88.55	20.55	17.4	3.15
	1.2	109.2	108.0 to 110.0	88.55	20.65	17.5	3.15
	1.3	109.3	108.0 to 110.0	88.55	20.75	17.6	3.15
	1.4	109.4	108.0 to 110.0	88.55	20.85	17.7	3.15
	1.5	109.5	108.0 to 110.0	88.55	20.95	17.8	3.15
	1.6	109.6	108.0 to 110.0	88.55	21.05	17.9	3.15
	1.7	109.7	108.0 to 110.0	88.55	21.15	18.0	3.15
	1.8	109.8	108.0 to 110.0	88.55	21.25	18.1	3.15
	1.9	109.9	108.0 to 110.0	88.55	21.35	18.2	3.15
110	0.0	110.0	110.0 to 112.0	90.55	19.45	16.3	3.15
	0.1	110.1	110.0 to 112.0	90.55	19.55	16.4	3.15

4-13. TUNING.

The 314U Frequency Control Unit provides for the selection of any one of 280 channels by use of 28 one megacycle positions, and 10 one-tenth megacycle positions. Because of design considerations, these 280 channels are obtained in slightly different combinations in the receiver itself. In the receiver the megacycle Autopositioner controls 14 two megacycle positions and the one-tenth megacycle Autopositioner controls 20 one-tenth megacycle positions. Thus the remote decimal system of 28 x 10 is converted to a 14 x 20 system in the receiver. This is accomplished by means of relay K-103 in conjunction with auxiliary remote control switching shown in figure 12-7.

4-14. DETECTOR AND AUDIO SECTION.

A diode detector is used to demodulate the signal at the 3rd fixed i-f amplifier stage. One section of the detector operates as a signal detector and the other operates in conjunction with the detector section to form a voltage doubling avc source. The avc system maintains the output constant over a wide range of incoming signal levels. A peak clipping series type noise limiter circuit follows the detector-avc rectifier circuit. The noise limiter is followed by an audio squelch circuit. This circuit biases the 1st audio amplifier stage to cut-off when no signal is being received. A two stage audio amplifier supplies audio signals to the headset or intercommunication system.

AUTOPOSITIONER SYSTEM.

4-15. GENERAL SYSTEM OPERATION.

To provide automatic remote selection of frequency the 51R-3 Receiver is equipped with an Autopositioner rotary positioning system. This system consists of two Autopositioner units driven by a common motor and a 9-wire simplified control system. The megacycle-determining Autopositioner unit is controlled by the megacycle-selecting switch on the 314U Control Unit and operates the crystal selector switch associated with the h-f injection oscillator-multiplier, as well as the slug rack which tunes the receiver r-f circuits. The tenth-magacycle Autopositioner unit is controlled by the tenth-megacycle selecting switch of the frequency selector unit, and operates the crystal switch associated with the l-f injection oscillator-multiplier, as well as the slug rack associated with the tunable i-f amplifier. The Autopositioners, motor, and drive gears are all mounted on the front panel of the receiver and covered by a dust cover fastened to the panel.

4-16. COMPONENTS.

The Autopositioner is a motor-driven mechanism which will position a shaft to any one of a number of fixed positions by remote control. The basic elements of the Autopositioner, as shown in figure 4-11 consists of a motor and its gear reduction, a slip clutch, a rotary shaft to which is fastened a notched stop-wheel, a pawl which engages the notches of the stop-wheel, and a solenoid which actuates the pawl and also operates a set of electrical contacts to start and stop the motor. Associated with each Autopositioner unit is an electrical control system consisting of a remotely located control switch actuated by the frequency-selector knob and a similar seeking switch driven by the Autopositioner shaft. This control system is of the "open-circuit seeking" type, designed so that whenever the control switch and seeking switch are not set to the same electrical position, the Autopositioner unit is energized and operates to drive its shaft (and the driven elements to which it is coupled) to the proper position to restore the symmetry of the control system.

4-17. CYCLE OF OPERATION. (See figure 4-11)

The cycle of operation of the Autopositioner is as follows:

a. The system is at rest with the control and seeking switches in corresponding positions (open circuit), solenoid in de-energized position, pawl engaging a stopwheel notch, and motor not energized.

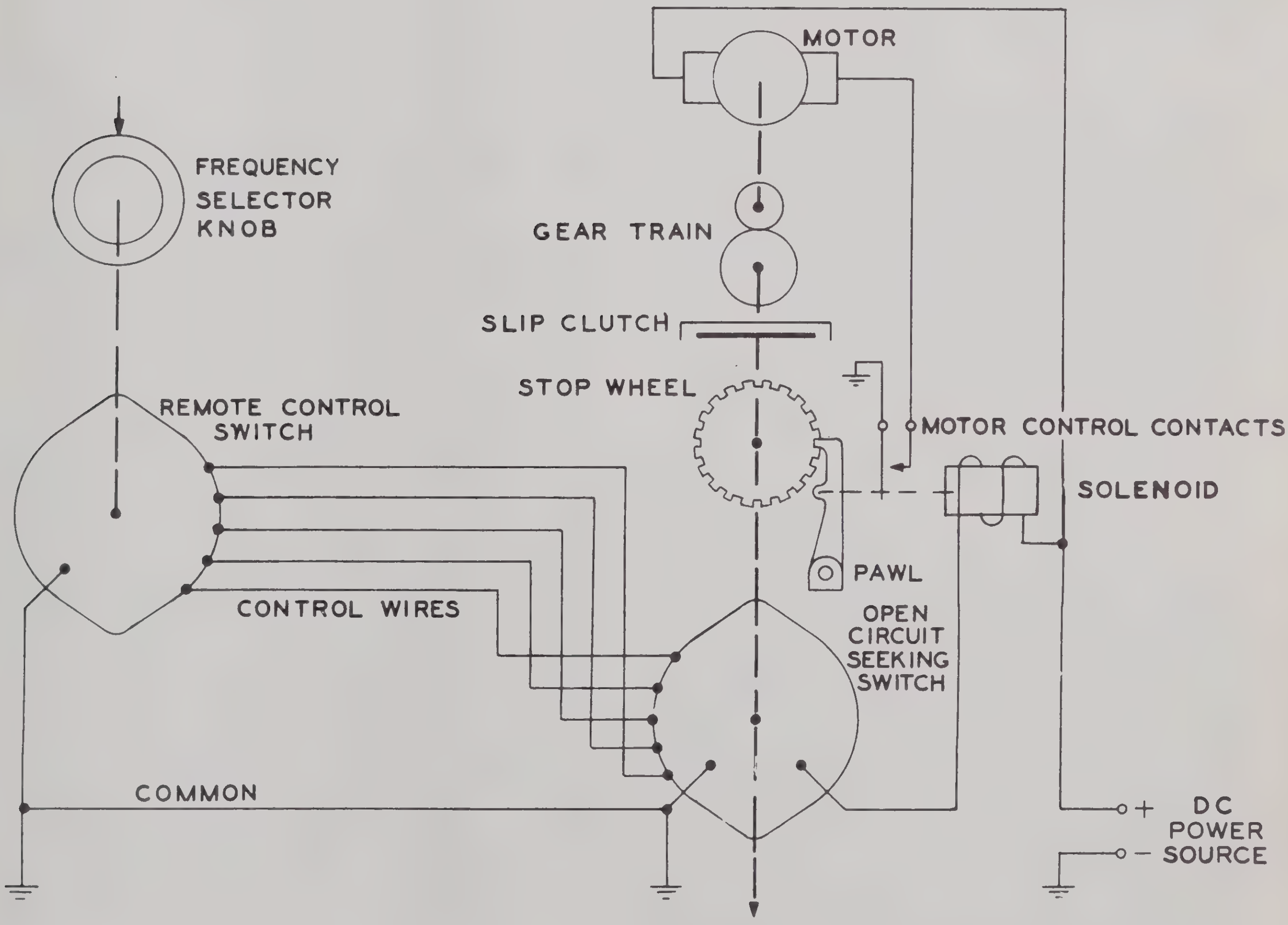

MOTOR
FREQUENCY
SELECTOR
KNOB
GEAR TRAIN
SLIP CLUTCH
STOP WHEEL
REMOTE CONTROL
SWITCH
MOTOR CONTROL CONTACTS
SOLENOID
PAWL
CONTROL WIRES
OPEN
CIRCUIT
SEEKING
SWITCH
COMMON
+ DC
POWER
− SOURCE

Figure 4-11. Autopositioner Functional Diagram

b. The operator changes the setting of the remote control selector switch.

c. The control system energizes the solenoid, thus lifting the pawl out of the stop-wheel notch and closing the motor control contacts.

d. The motor starts, driving the Autopositioner shaft and the rotor of the seeking switch.

e. The seeking switch reaches the point corresponding to the new position of the remote switch. This opens the solenoid circuit and permits the pawl to drop into the corresponding stop-wheel notch to stop the shaft rotation.

f. The motor control contacts open and the motor coasts to a stop, dissipating its kinetic energy in the slip clutch.

The seeking switch of the control circuit is adjusted to open the solenoid circuit shortly before the stop-wheel reaches the point where the pawl engages the proper notch. The solenoid contacts controlling the motor are mechanically operated by the pawl arm so that they do not open until the pawl does drop into the notch. Note that the slip clutch between the motor and Autopositioner not only absorbs the energy of the motor as it coasts to a stop, but also permits the same motor to drive more than one Autopositioner, either simultaneously or independently. When this is done the motor control contacts of the Autopositioner solenoids are connected in parallel to keep the motor operating as long as either of the Autopositioners is energized.

4-18. AUTOPOSITIONER CONTROL SYSTEM.

To provide a positive control system for the Autopositioners with a minimum number of control wires, a special simplified control system is employed, using the control wires in various different combinations. Four wires are employed to control the megacycle Autopositioner unit (14 active positions), and five control wires are used to control the tenth-megacycle Autopositioner (20 active positions). A common return ground wire is used for both sections of the circuit.

4-19. CONTROL CIRCUITS.

This system is most readily explained by considering a system composed of single-pole double throw switches as shown in figure 4-12.

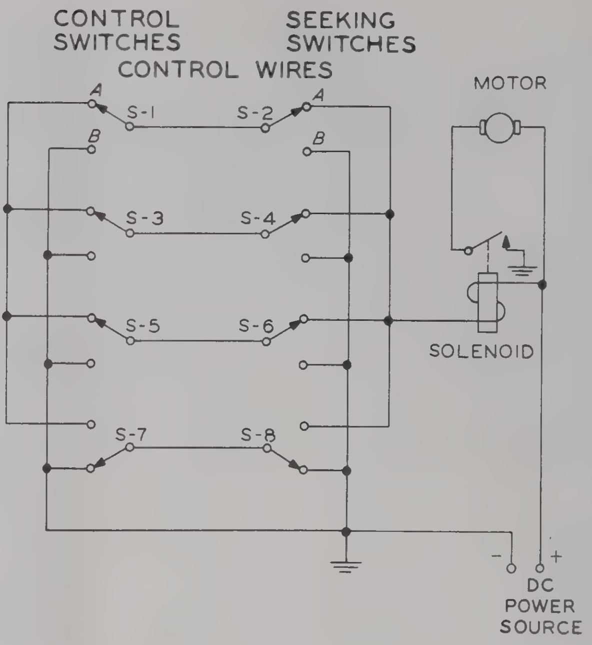


Figure 4-12. Simplified Control System Diagram

Note that when the switches are set symmetrically (S-1 in the same position as S-2, etc., as shown), there is no current path from the solenoid coil to ground, and the solenoid and motor remained de-energized. If, however, any one of the control switches is set to a position opposite to that of the corresponding seeking switch, a path to ground will be closed, energizing the solenoid and motor until the seeking switches are repositioned (by means discussed below) to positions symmetrical to the control switches, which will again open the solenoid circuit. The total number of different combinations of switch positions in such a system is 2^n, where "n" is the number of control wires used. In the four-wire system shown, $2^4=16$ different combinations exist. However, one particular combination is not usable in this application. As can be seen from figure 4-12, if all the seeking switches are set to the "B" position, there can be no path from the solenoid coil to ground, no matter how the control switches are set, and the system is dead. Hence the maximum number of usable combinations in such a system is 2^n-1. Thus, a 3-wire system can control 7 positions, 4 wires 15 positions, 5 wires 31 positions, etc.

To make the system of figure 4-12 physically usable for controlling rotary shaft positions, leaf-type single-pole double-throw switches could be used, actuated by means of a group of four cams mounted on the rotary shaft, the cams being cut to actuate the switches to a different combination for each shaft position, identical cams and switches being used on the remote control shaft and on the motor-driven shaft. To eliminate the bulk and complexity of such an arrangement, special rotary wafer-type switches are used to perform the same function. These switches are shown in the schematic diagram, figure 12-7. Each switch consists of two rotor blades, mounted on opposite sides of the switch rotor and insulated from each other. These take the place of the "A" and "B" parallel-bus connections of figure 4-12.

Looking at switch S-401A in figure 12-7 for example, the control wires A, B, C and D terminate in contacts 3, 4, 5 and 6. These contacts consist of clips on both sides of the switch. Since the two blades are cut to complementary patterns, each control wire is connected to either the front or rear blade of the switch as the switch rotor is turned. The clips and blades cooperate, therefore, to produce a system of two-position contractors analogous to the system shown in figure 4-12.

4-20. SEEKING SWITCH.

The seeking switch, S-101, in figure 12-7 is similar to the remote switch S-401A in that it presents the same sequence of front and rear blade connection to the clips 15, 16, 17, and 18, which are the other terminal points of control wires A-D. When the two switches are on corresponding positions, both ends of each control wire contact the same side (front or rear) of the respective switches. In this position the solenoid circuit is open, since the front blades of both switches are grounded by means of the long clips shown, and the rear blade of S-101 is connected to the Autopositioner solenoid by the long clip at position 5. Note that S-101 is a 20-position switch whereas S-401A is a 14-position switch. The six extra positions on S-101 provide a return section for the slug rack cams. The megacycle Autopositioner is prevented from stopping on any of these unused positions by the section (shown at the top of the switch) in which both the front and rear blades project. When this section of the rotor blades makes contact with any of the control wire clips, a direct path from the solenoid to ground is closed, and the solenoid is kept energized.

4-21. MEGACYCLE REMOTE SWITCH.

Since the megacycle tuning is done in steps of 2 mc, switch S-401A is constructed to maintain the same electrical connections on control wires A through D for two successive positions of the megacycle frequency selector knob: 108 and 109 mc, 110 and 111 mc, etc., as shown by the chart in figure 12-7. Interpolation of the one megacycle steps from 108 to 109 mc, 110 to 111 mc, etc., is accomplished by means of switch S-401B, control wire J, auxiliary relay K-103, and switch S-104. On the odd-numbered megacycle positions of the selector knob, switch S-401B energizes relay K-103 by grounding wire J. This actuates the contacts of K-103 to ground the wire going to clip 5 of switch S-104. On the even-numbered positions, relay K-103 is de-energized, and grounds clip 15 of S-104, as shown in figure 12-7.

4-22. TENTH-MEGACYCLE REMOTE SWITCH.

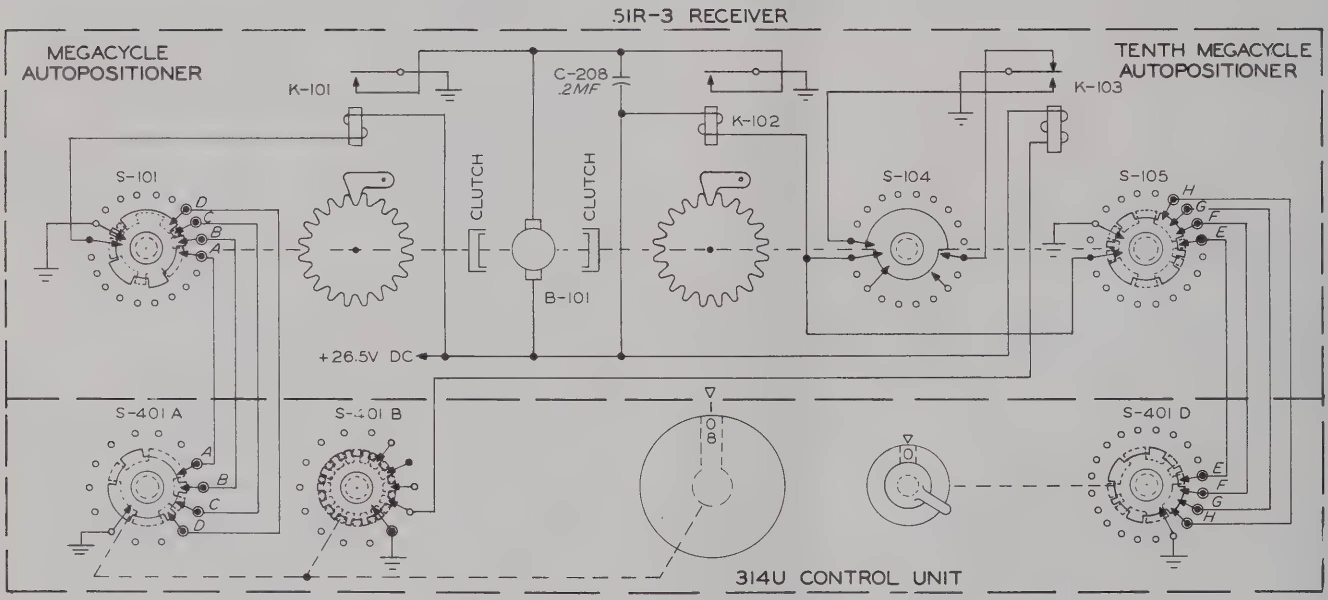
The tenth-megacycle remote switch S-401D and the corresponding seeking switch S-105 are physically and electrically similar. Each is a 20-position switch providing 10 different circuit combinations of control wires, E, F, G and H, the sequence of 10 combinations being repeated twice for one complete revolution of the switch. The remote switch S-401D is limited to 10 positions by stops, but the seeking switch S-105 may stop in either of two positions, 180 degrees apart, and find the proper combination to open the main circuit. Which of these two positions satisfies the Autopositioner system is determined by the auxiliary relay K-103 and switch S-104, which serve to keep the Autopositioner relay circuit energized for the unwanted half of the revolution. With the megacycle control knob set on an even frequency, as shown, clip 15 on switch S-104 is grounded, and the tenth-megacycle Autopositioner may be positioned at from 0.0 through 0.9 mc, corresponding to the position of the tenth-megacycle control knob. Advancing the megacycle control knob to the successive odd-numbered frequency does not change the circuit of wires A through D and therefore does not operate the megacycle Autopositioner, Instead, it grounds wire J, energizing relay K-103 and grounding clip 5 of switch S-104. This energizes the tenth-megacycle Autopositioner, causing it to advance 180 degrees to the alternate position of switch S-105, in the range of 1.0 through 1.9 mc corresponding to the position one megacycle above the figure shown on the tenth-megacycle control knob. Thus the tenth-megacycle Autopositioner tunes receiver in 20 steps of 0.1 mc each to interpolate between the 2 mc steps and the megacycle Autopositioner, whereas, the remote control knobs and dials present the frequency data in a decade system of 1 mc and 0.1 steps.

4-23. DETAILED SEQUENCE OF OPERATION.

A detailed sequence of operation of the megacycles and tenth-megacycle Autopositioners and control circuits is shown in figure 4-13.

NOTES

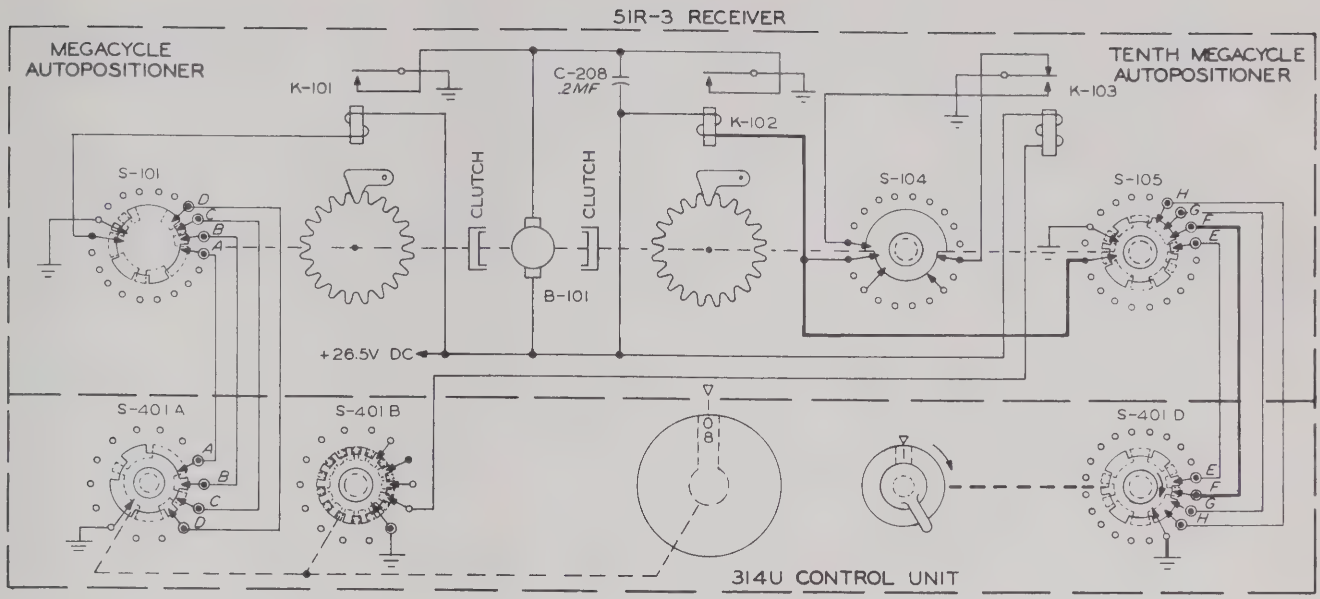
B-101 Autopositioner motor.
K-101 Megacycle (course frequency) solenoid.
K-102 Tenth-megacycle (fine frequency) solenoid.
K-103 Auxiliary relay
Wires carrying current shown in heavy lines.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208
.2MF
K-102
K-103
S-101
D
C
B
A
CLUTCH
CLUTCH
B-101
S-104
S-105
H
G
F
E
+26.5V DC
S-401 A
A
B
C
D
S-401 B
0
8
0
S-401 D
E
F
G
H
314U CONTROL UNIT

STEP #1

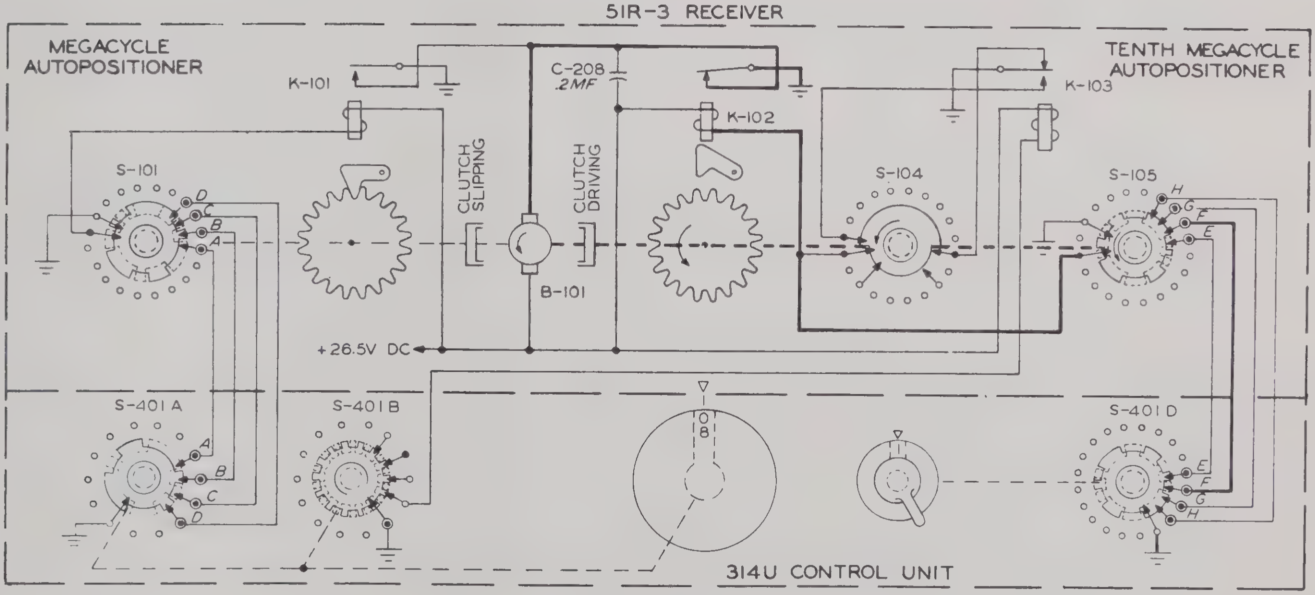
a. It is desired to select a receiver frequency of 111.1 mc.
b. Autopositioner is at rest with receiver tuned to 108.0 mc.
c. Voltage is available to control system. A ground must be supplied before system will operate.

Figure 4-13. Autopositioner Sequence of Operation (Step #1 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
K-101
C-208
.2MF
K-102
K-103
TENTH MEGACYCLE AUTOPOSITIONER
S-101
D
C
B
A
CLUTCH
CLUTCH
B-101
S-104
S-105
H
G
F
E
+26.5V DC
S-401 A
A
B
C
D
S-401 B
0
8
S-401 D
E
F
G
H
314U CONTROL UNIT

STEP #2

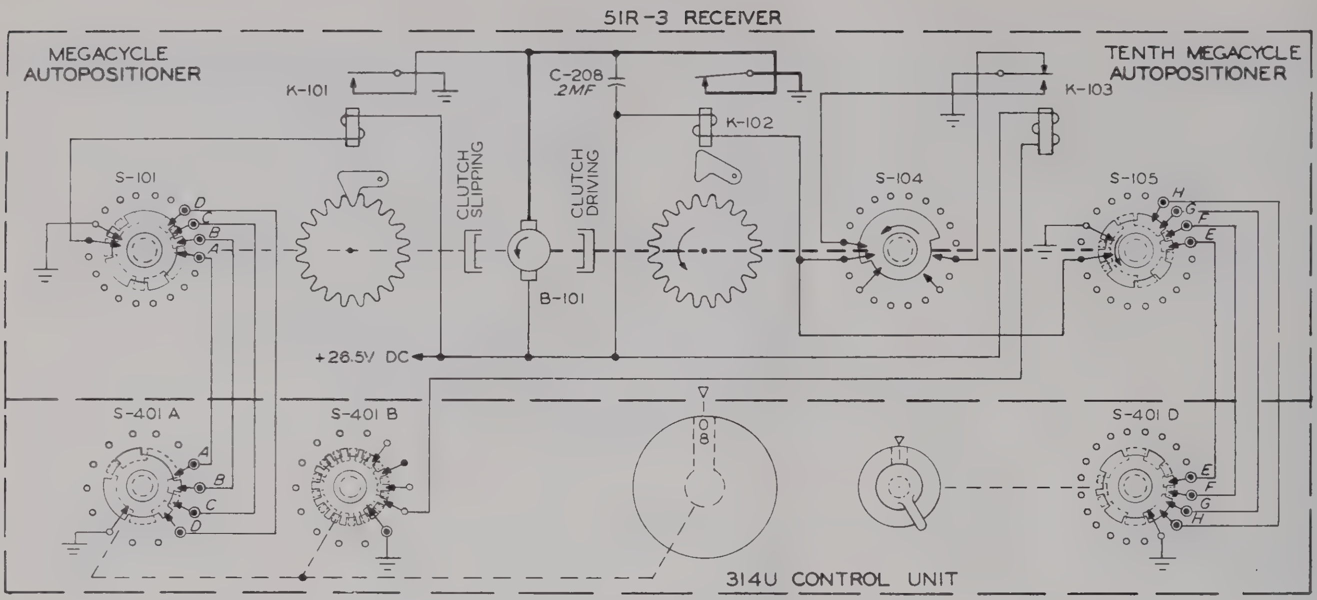
a. Tenth-megacycle selector on 314U Control Unit is rotated to the .1 mc position.
b. Switches S-401D and S-105 cooperate to place ground on coil of solenoid K-102, energizing the solenoid.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
K-101
C-208
.2MF
K-102
K-103
TENTH MEGACYCLE AUTOPOSITIONER
S-101
D
C
B
A
CLUTCH SLIPPING
CLUTCH DRIVING
B-101
S-104
S-105
H
G
F
E
+26.5V DC
S-401 A
A
B
C
D
S-401 B
0
8
S-401 D
E
F
G
H
314U CONTROL UNIT

STEP #3

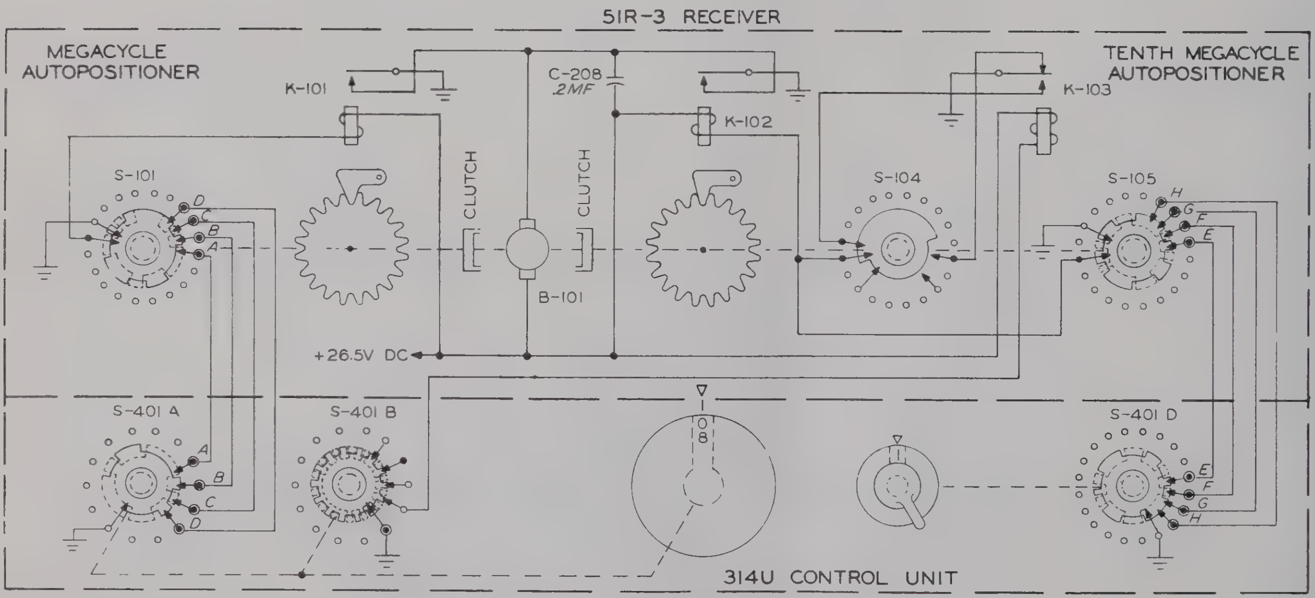
a. Contacts of K-102 operate, closing motor energizing circuit and lifting pawl out of toothed wheel of tenth-megacycle Autopositioner.
b. Motor B-101 rotates driving toothed wheel of tenth-megacycle Autopositioner and switches S-104 and S-105 through clutch.
c. Clutch of megacycle Autopositioner slips.

Figure 4-13. Autopositioner Sequence of Operation (Steps #2 and #3 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-103
K-102
S-101
CLUTCH SLIPPING
CLUTCH DRIVING
S-104
S-105
B-101
+26.5V DC
S-401 A
S-401 B
S-401 D
314U CONTROL UNIT
A
B
C
D
E
F
G
H
0
8

STEP #4

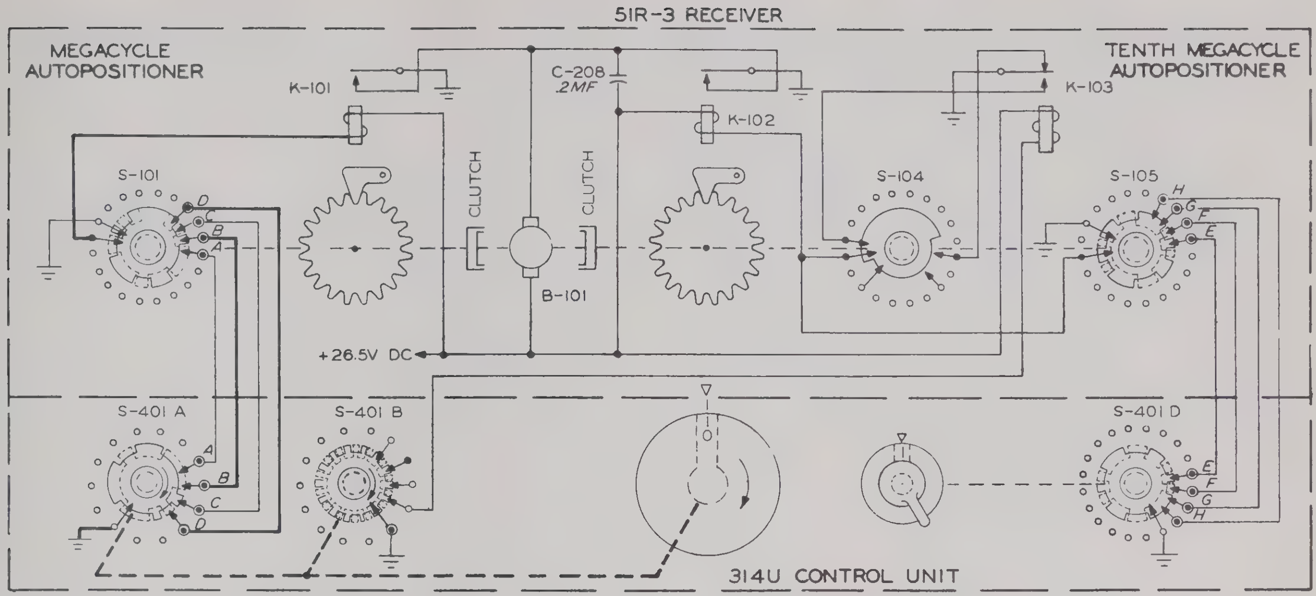
a. Tenth-megacycle Autopositioner reaches position where S-401D and S-105 are in corresponding positions.
b. Continuity is broken between the solenoid coil of K-102 and ground.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-103
K-102
S-101
CLUTCH
CLUTCH
S-104
S-105
B-101
+26.5V DC
S-401 A
S-401 B
S-401 D
314U CONTROL UNIT
A
B
C
D
E
F
G
H
0
8

STEP #5

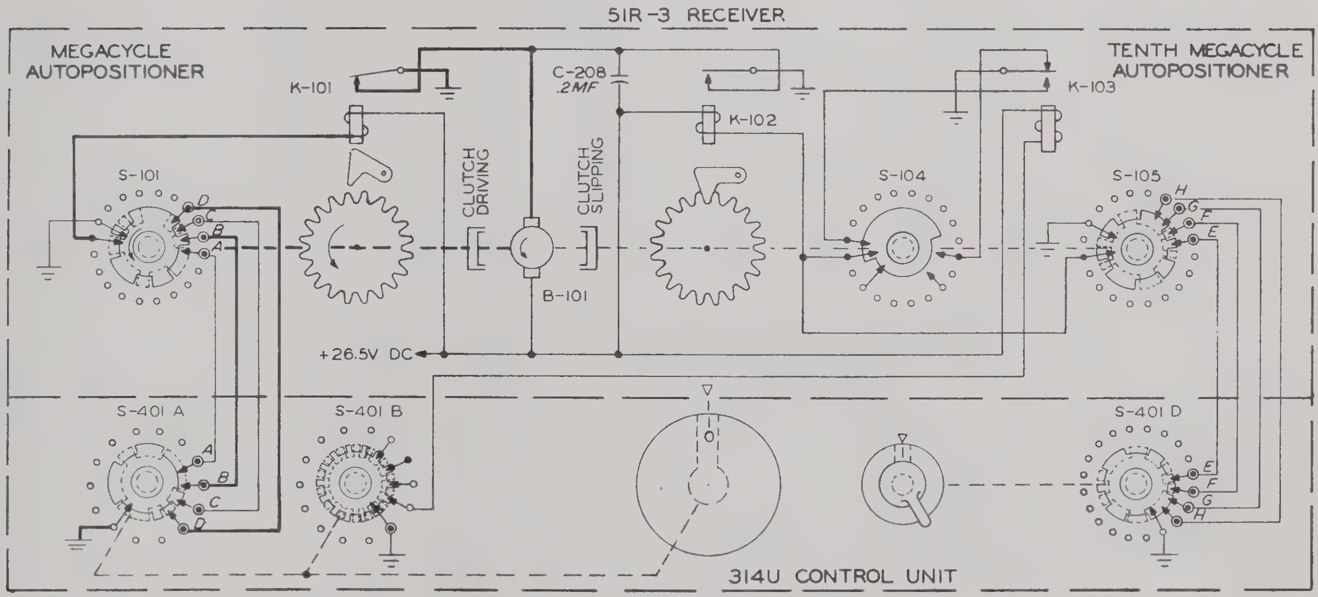
a. Solenoid K-102 releases, dropping the pawl into a slot of the toothed wheel and removing voltage from motor B-101.
b. System comes to rest at 108.1 mc.

Figure 4-13. Autopositioner Sequence of Operation (Steps #4 and #5 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH
CLUTCH
B-101
+26.5V DC
S-401 A
S-401 B
S-401 D
A
B
C
D
E
F
G
H
0
314U CONTROL UNIT

STEP #6

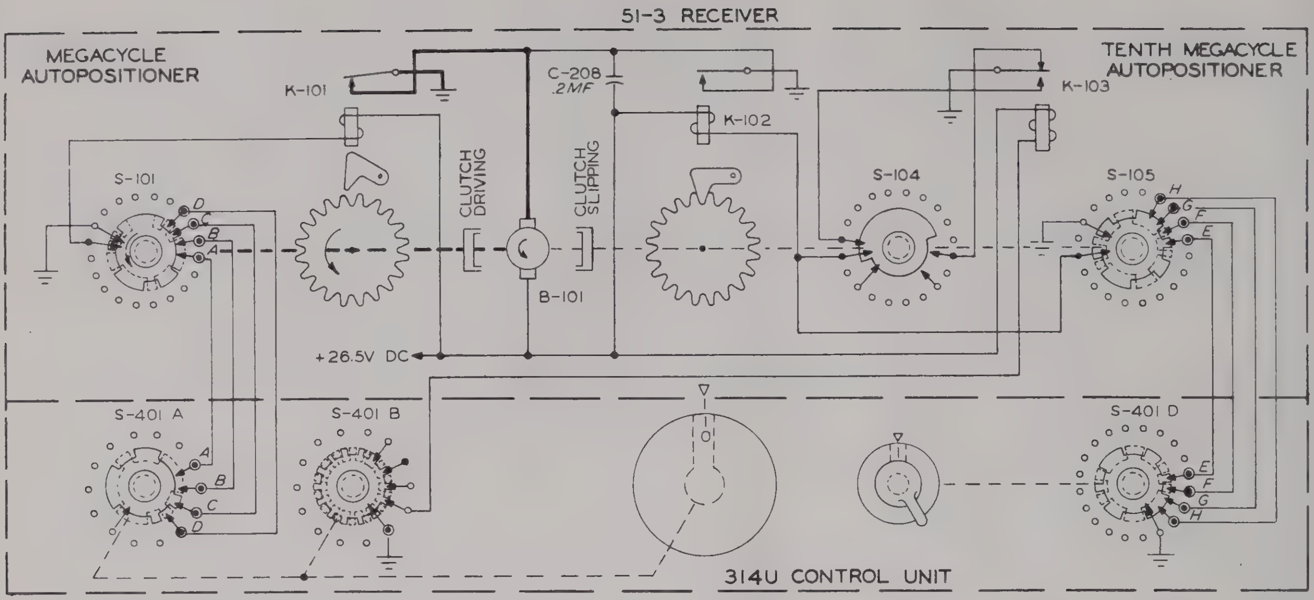
a. Megacycle selector switch is in process of rotation to 111.0 mc position and reaches 110.0 mc.
b. Switches S-401A and S-101 cooperate to provide a ground connection to the coil of solenoid K-101.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH DRIVING
CLUTCH SLIPPING
B-101
+26.5V DC
S-401 A
S-401 B
S-401 D
A
B
C
D
E
F
G
H
0
314U CONTROL UNIT

STEP #7

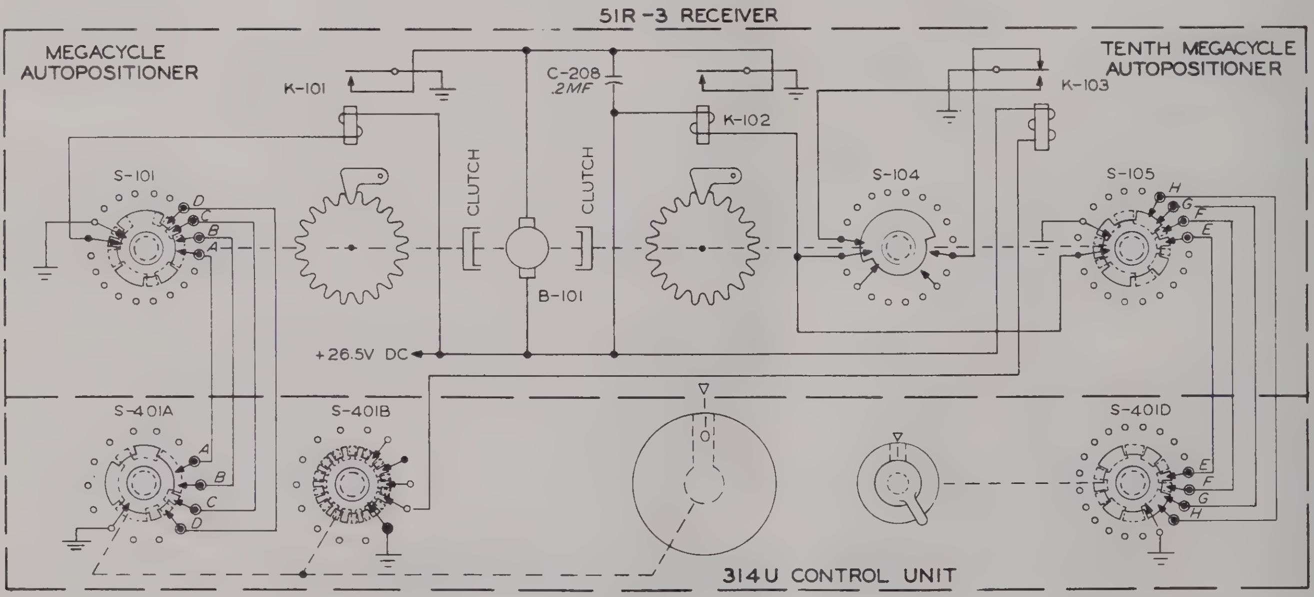
a. Solenoid K-101 raises pawl from toothed wheel of megacycle Autopositioner and energizes the motor B-101.
b. Motor B-101 rotates, driving the toothed wheel and S-101 through the clutch.
c. Tenth-megacycle Autopositioner clutch slips.

Figure 4-13. Autopositioner Sequence of Operation (Steps #6 and #7 of 14 steps)


51-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
D
C
B
A
CLUTCH DRIVING
CLUTCH SLIPPING
S-104
S-105
H
G
F
E
B-101
+26.5V DC
S-401 A
A
B
C
D
S-401 B
S-401 D
E
F
G
H
0
314U CONTROL UNIT

STEP #8

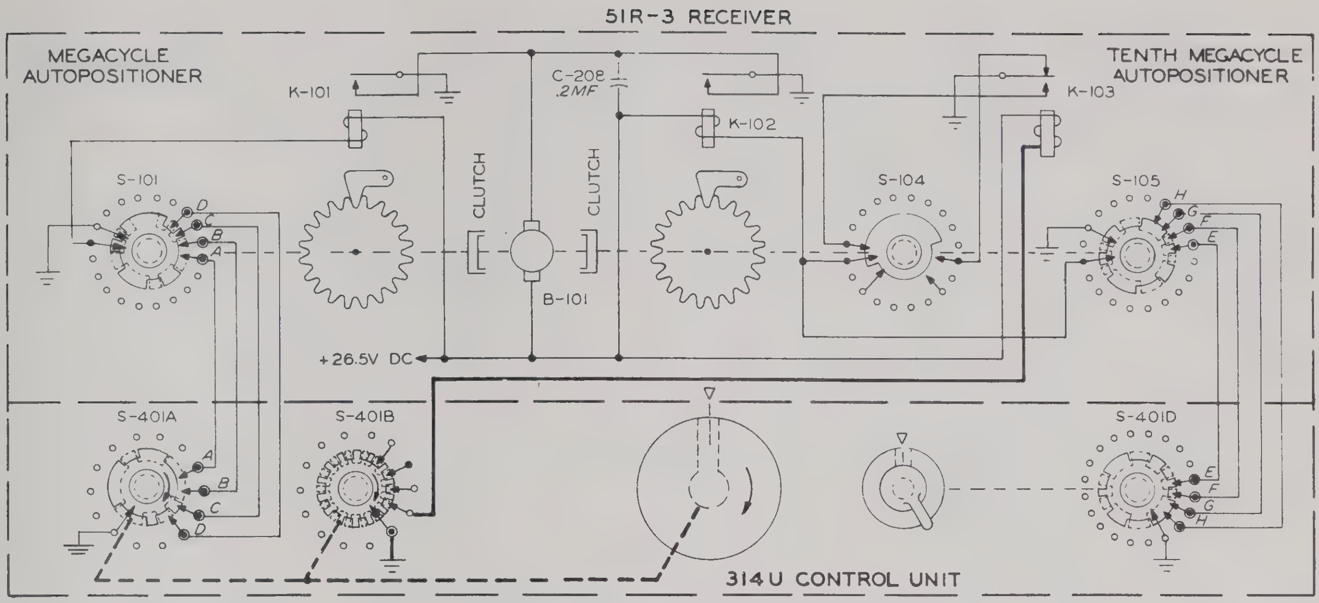
a. Megacycle Autopositioner reaches position where S-101 and S-401A are in corresponding positions.
b. Continuity is broken between the solenoid coil of K-101 and ground.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
D
C
B
A
CLUTCH
CLUTCH
S-104
S-105
H
G
F
E
B-101
+26.5V DC
S-401A
A
B
C
D
S-401B
S-401D
E
F
G
H
0
314U CONTROL UNIT

STEP #9

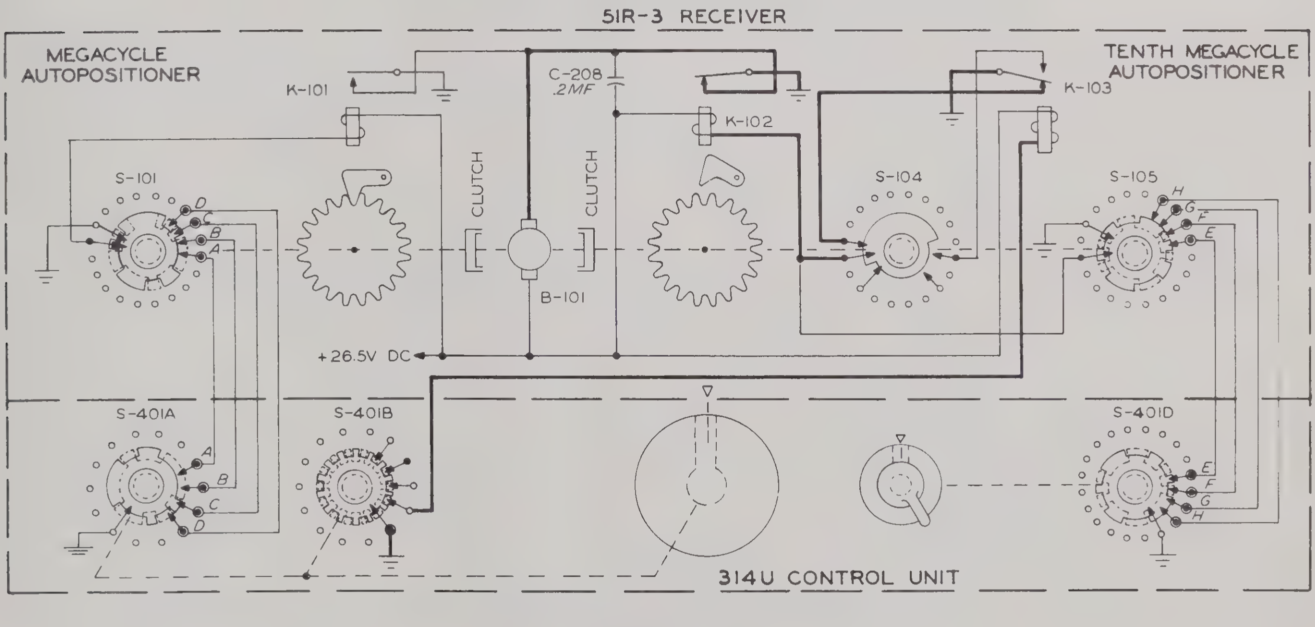
a. Solenoid K-101 releases, dropping the pawl into a slot of the toothed wheel and removing voltage from motor B-101.
b. System comes to rest at 110.1 mc.

Figure 4-13. Autopositioner Sequence of Operation (Steps #8 and #9 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH
CLUTCH
B-101
+26.5V DC
S-401A
S-401B
S-401D
314U CONTROL UNIT
A
B
C
D
E
F
G
H

STEP #10

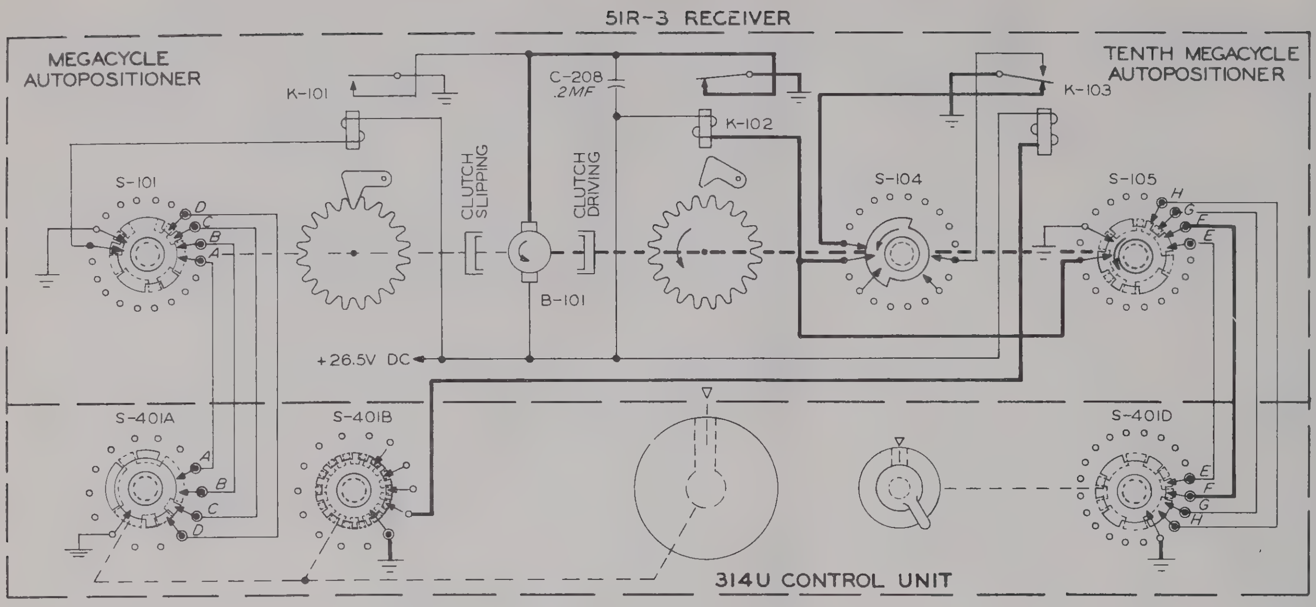
a. Megacycle selector switch is rotated to 111.0 mc position.
b. Switch S-401B supplies ground to coil of relay K-103.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH
CLUTCH
B-101
+26.5V DC
S-401A
S-401B
S-401D
314U CONTROL UNIT
A
B
C
D
E
F
G
H

STEP #11

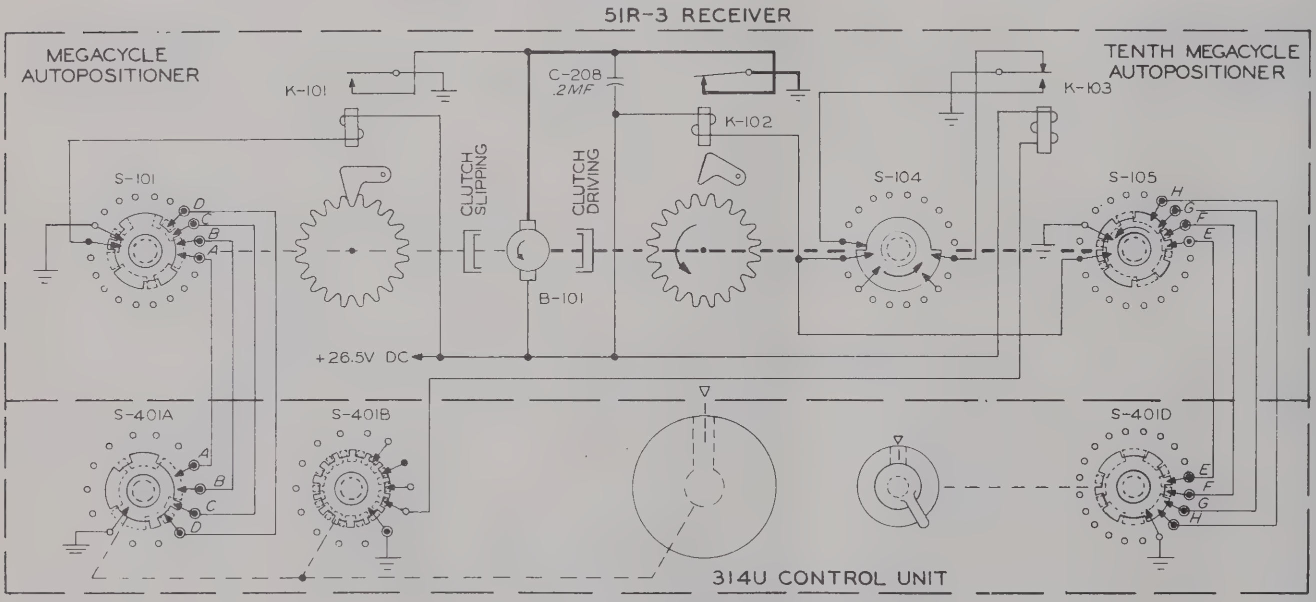
a. Relay K-103 closes, placing a ground on the solenoid coil of K-102.
b. Solenoid K-102 raises the pawl from the toothed wheel and energizes the motor B-101.

Figure 4-13. Autopositioner Sequence of Operation (Steps #10 and #11 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH SLIPPING
CLUTCH DRIVING
B-101
+26.5V DC
S-401A
S-401B
S-401D
A
B
C
D
E
F
G
H
314U CONTROL UNIT

STEP #12

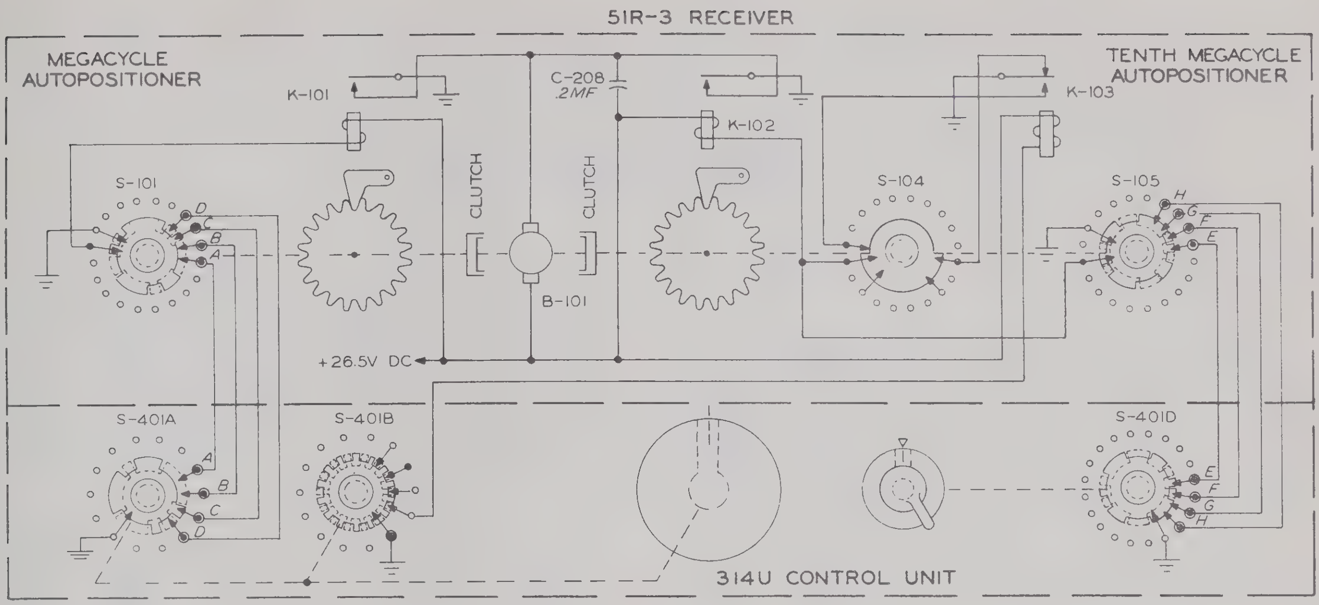
a. Motor B-101 rotates, driving the toothed wheel and switches S-104 and S-105 through the clutch.
b. Megacycle Autopositioner clutch slips.


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
TENTH MEGACYCLE AUTOPOSITIONER
K-101
C-208 .2MF
K-102
K-103
S-101
S-104
S-105
CLUTCH SLIPPING
CLUTCH DRIVING
B-101
+26.5V DC
S-401A
S-401B
S-401D
A
B
C
D
E
F
G
H
314U CONTROL UNIT

STEP #13

a. Tenth-megacycle Autopositioner reaches a position 180 degrees from starting position. S-105 and S-401D are in symmetrical positions.
b. S-104 no longer supplies ground to K-102.

Figure 4-13. Autopositioner Sequence of Operation (Steps #12 and #13 of 14 steps)


51R-3 RECEIVER
MEGACYCLE AUTOPOSITIONER
K-101
C-208
.2MF
K-102
TENTH MEGACYCLE AUTOPOSITIONER
K-103
S-101
D
C
B
A
CLUTCH
CLUTCH
B-101
S-104
S-105
H
G
F
E
+26.5V DC
S-401A
A
B
C
D
S-401B
S-401D
E
F
G
H
314U CONTROL UNIT

STEP #14

a. Solenoid K-102 releases, dropping the pawl into a slot of the toothed wheel and removing voltage from motor B-101.
b. System comes to rest at 111.1 mc.

Figure 4-13. Autopositioner Sequence of Operation (Step #14 of 14 steps).

SECTION 5

CIRCUIT DESCRIPTION

5-1. INTRODUCTION.

The basic principles used in the 51R-3 Navigation Receiver System were described in the previous section on theory of operation. In Section 5 the circuitry and components used in applying these principles to accomplish the desired functions are described. Throughout this section frequent reference should be made to the main schematic diagram, figure 12-1 as well as the simplified schematic diagrams in this section.

5-2. R-F SECTION.

a. R-F AMPLIFIER. - Signals from the antenna are coupled to the r-f amplifier through slug tuned transformer T-101 in the grid circuit of V-101. The slug in T-101 is positioned by the megacycle autopositioner in a manner to tune the grid circuit in two megacycle steps from 108. mc through 135. 9 mc. Double tuned transformer T-102 couples the amplified r-f signal to the grid of the 1st mixer, V-102. Slugs in its primary and secondary tune the plate circuit of the r-f amplifier and grid circuit of the 1st mixer in the same steps as T-101 is tuned.

b. FIRST OSCILLATOR AND MIXER. - The 1st mixer injection signal originates in a Butler type oscillator using any one of 14 overtone type crystals in the range 44.275 through 57.275 mc. The plate circuit of the grounded grid section of V-112 is tuned to the crystal frequency by a slug in L-102 positioned by the megacycle Autopositioner. T-118 couples signal in the plate circuit of the cathode follower section of V-112 to the grid of the h-f injection amplifier, V-111. T-118 is tuned to the second harmonic of the crystal fundamental frequency by a slug positioned by the megacycle Autopositioner. The plate circuit of V-111 is tuned to the second harmonic of the crystal frequency by the primary of T-111 and is coupled to the grid of 1st mixer V-102 through the tuned secondary of T-111 and coupling capacitor C-118.

c. VARIABLE I-F AMPLIFIER. - The parallel fed plate circuit of 1st mixer V-102 is tuned to the difference frequency of the r-f input and 1st injection oscillator signals by the primary of T-103. Two slugs in T-103 are positioned by the one-tenth megacycle Autopositioner in a manner to tune the mixer plate and variable i-f amplifier grid circuits in one-tenth megacycle steps from 19.45 through 21.35 mc. Identical tuning is used for T-104 in the plate circuit of V-103 and grid circuit of 2nd mixer V-104.

d. SECOND OSCILLATOR AND MIXER. - The second mixer injection signal originates in a low frequency crystal oscillator consisting of V-113 and crystals Y-115 through Y-134 which are switched by the one-tenth megacycle Autopositioner. The plate circuit of V-113 is tuned to the second harmonic of the crystal frequency by slugs positioned in T-110 by the one-tenth megacycle Autopositioner. The similarily tuned secondary of T-110 couples the second harmonic signal to the grid of 2nd mixer V-104. Transformer T-105 in the plate circuit of 2nd mixer V-104 is tuned to the difference frequency of the variable i-f signal and the second injection oscillator signal. This difference frequency is always 3. 15 mc.

e. FIXED I-F AMPLIFIER. - The fixed i-f amplifier consists of three stages coupled by double tuned transformers T-105, T-106, T-107, and T-108. The stages differ in the values of cathode bias resistors and bypass capacitors used. Avc voltage is applied to the grids of V-101, V-103, V-104, V-105, and V-106. Avc voltage is not applied to the last stage V-107, nor to the first mixer, V-102.

5-3. DETECTOR AND AVC SYSTEM.

The secondary of the last fixed i-f amplifier transformer, T-108, is connected to a detector circuit consisting of a diode signal detector V-108, as rectifier, R-142 as load resistor and C-161 as r-f filter. The other diode of V-108 is reversed and operates in conjunction with the signal diode to form a voltage doubling avc source. This voltage doubling circuit enables the avc system to maintain receiver output substantially constant over a wide range of incoming signal levels.

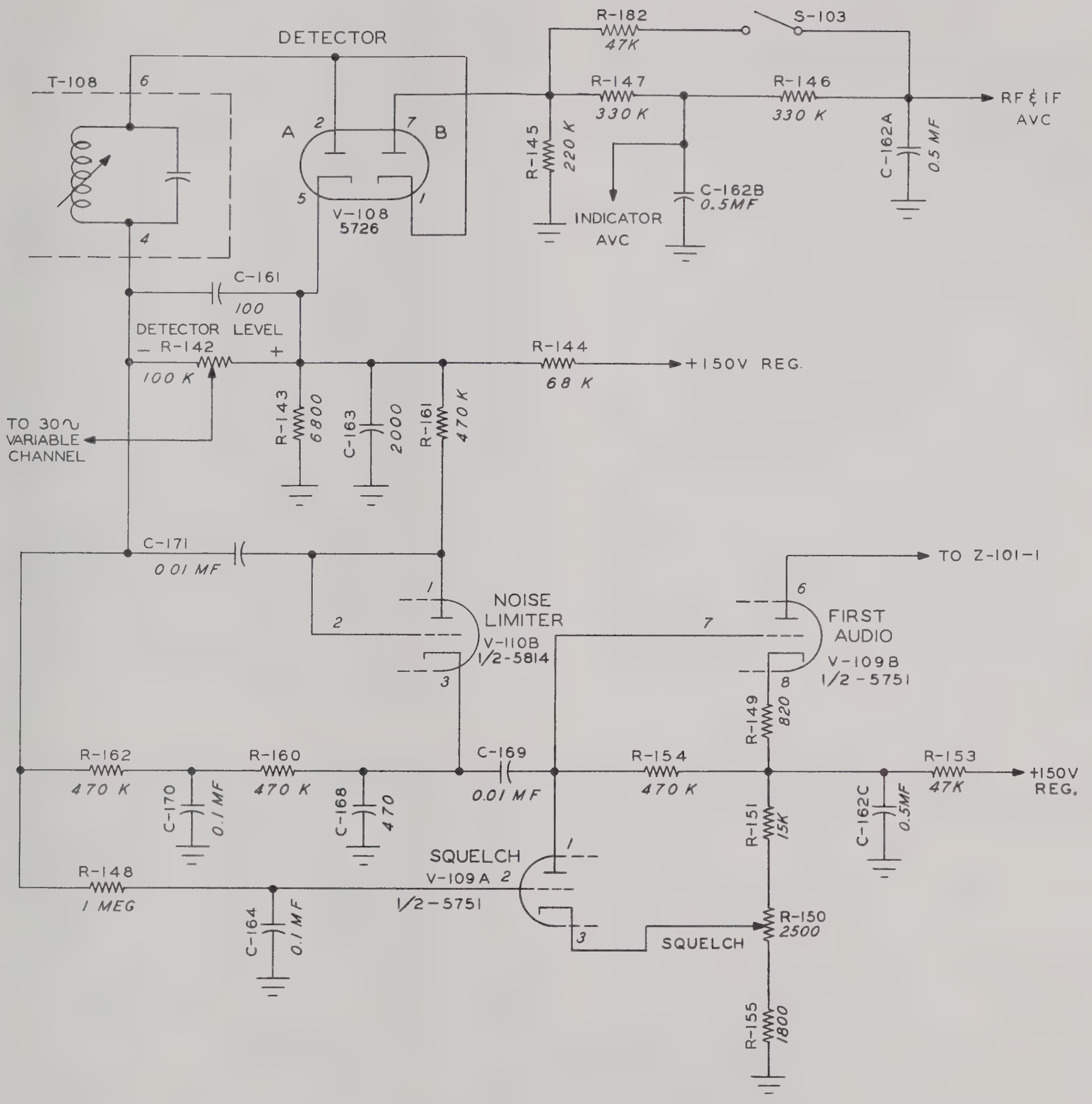

DETECTOR
T-108
6
4
A
B
2
7
5
1
V-108
5726
R-182
47K
S-103
R-147
330 K
R-146
330 K
RF & IF AVC
R-145
220 K
INDICATOR AVC
C-162B
0.5MF
C-162A
0.5 MF
C-161
100
DETECTOR LEVEL
— R-142 +
100 K
TO 30∿ VARIABLE CHANNEL
R-143
6800
C-163
2000
R-161
470 K
R-144
68 K
+150V REG.
C-171
0.01 MF
NOISE LIMITER
V-110B
1/2-5814
1
2
3
TO Z-101-1
FIRST AUDIO
V-109B
1/2-5751
6
7
8
R-149
820
R-162
470 K
C-170
0.1 MF
R-160
470 K
C-168
470
C-169
0.01 MF
R-154
470 K
R-151
15K
C-162C
0.5MF
R-153
47K
+150V REG.
SQUELCH
V-109A
1/2-5751
1
2
3
R-148
1 MEG
C-164
0.1 MF
R-150
2500
SQUELCH
R-155
1800

Figure 5-1. 51R-3 Receiver, AVC, Detector, Noise Limiter and Squelch Circuits.

Operation of the avc circuit is as follows. (Refer to figure 5-1.) With a signal applied, section A of V-108 will conduct on the positive half cycles, charging capacitor C-161. Section B will conduct on the negative half cycle when the sum of the negative peak and the charge on C-161 exceeds that of the delay voltage. As the charge on C-161 is negative with respect to ground it is added to the negative peak of the signal, thus obtaining a voltage doubling effect. The rectified avc developed across R-145 is applied, through appropriate filters, to the indicator circuits and also to the controlled i-f and r-f stages of the receiver.

5-4. NOISE LIMITER. (See figure 5-1.)

The noise limiter utilizes section B of V-110 in a peak clipping series type limiter circuit. The plate of the limiter section of V-110 is connected through R-161 to the cathode side of the detector load resistor, R-142, and the cathode of the limiter tube, through the filter sections consisting of R-162, C-170, R-160, and C-168, to the opposite side of the detector load. In operation, the limiter tube conducts by virtue of the polarity of the dc potential across R-142. In the presence of an audio-modulated i-f signal the plate voltage of the limiter section of V-110 varies at an audio rate, since it is coupled to the detector load resistor, R-142, through C-171. This results in the limiter tube conducting at an audio rate. The resulting audio voltage developed across R-160 is applied to the grid of the first audio stage V-109B. If a sharp noise pulse, having an amplitude to cause modulation above a certain level and appearing at transformer terminal T-108.4 in the form of a sharp negative dc pulse after rectification, were coupled through C-171 to the plate of limiter V-110B, it would cause the voltage at the plate to decrease in amplitude an amount equal to that of the pulse. This would result in interrupted current flow through the limiter section of V-110 for the instant, and the noise above a certain level would not be allowed to appear in the grid circuit of the first audio stage. As the noise peaks are usually of short duration and the recovery time of the limiter is practically instantaneous, the interruption of the signal is not noticeable.

5-5. SQUELCH CIRCUIT. (See figure 5-1.)

The audio squelch system utilizes section A of V-109. The desired condition is that the 1st audio amplifier stage, section B of V-109, be biased to cut-off when no signal is being received. Section A of V-109, develops this biasing voltage as follows: The grid of V-109A is connected to the junction of T-108 and the diode load resistor, R-142, and utilizes the voltage developed across the diode load. With no signal received, the dc voltage at the junction of R-142 and T-108 is greater then the positive voltage across R-150, causing V-109A to conduct. The current develops a negative voltage across R-154 which is applied to the grid of the first audio amplifier, V-109B. This biases V-109B to cut-off and silences the receiver. When a signal is received, the junction of R-142 and T-108 becomes less positive causing the squelch tube to be biased to cut-off. With no current flowing, the bias voltage is removed from R-154, the 1st audio amplifier functions normally and the audio signal appears in the output of the first audio amplifier.

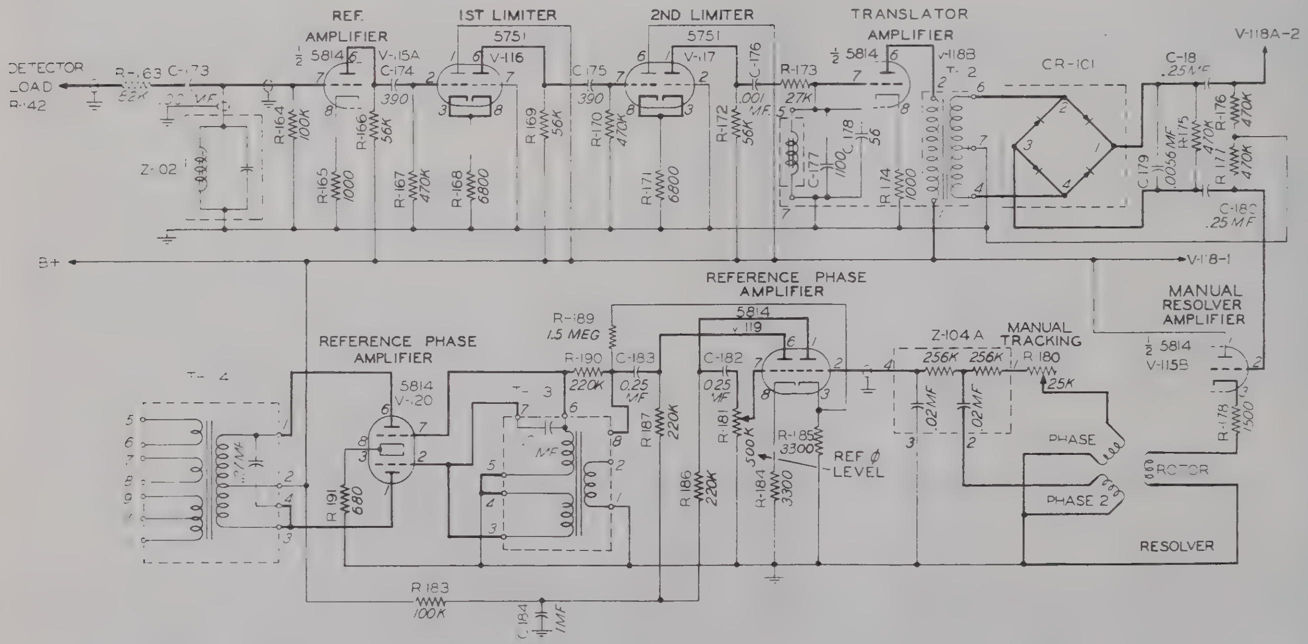

DETECTOR LOAD R-142
R-163 82K
C-173 .02 MF
Z-102
REF. AMPLIFIER
½ 5814 V-115A
C-174 390
R-164 100K
R-165 1000
R-166 56K
R-167 470K
1ST LIMITER
5751 V-116
R-168 6800
R 169 56K
C 175 390
2ND LIMITER
5751 V-117
R-170 470K
R-171 6800
R-172 56K
C-176 .001 MF
R-173 27K
C-177
C 178 56
TRANSLATOR AMPLIFIER
½ 5814 V-118B
T-102
R 174 1000
CR-101
C-18 .25 MF
C 179 .0056 MF
R-175 470K
R-176 470K
R 177 470K
C-180 .25 MF
V-118A-2
V-118-1
B+
REFERENCE PHASE AMPLIFIER
T-104
5814 V-120
R 191 680
T-103
MF
R-189 1.5 MEG
R-190 220K
C-183 0.25 MF
R 187 220K
R 186 220K
R 183 100K
C 184 1MF
REFERENCE PHASE AMPLIFIER
5814 V-119
C-182 0.25 MF
R-181 500K
R-184 3300
R-185 3300
REF ϕ LEVEL
Z-104 A
256K
256K
.02MF
.02MF
MANUAL TRACKING
R 180 25K
PHASE
PHASE 2
ROTOR
RESOLVER
MANUAL RESOLVER AMPLIFIER
½ 5814 V-115B
R-178 1500

Figure 5-2. Reference Phase Channel Simplified Schematic Diagram

5-6. REFERENCE PHASE CHANNEL. (See figure 5-2.)

The receiver output appears across the detector load R-142. The 9960 cps subcarrier frequency modulated by the 30 cps reference phase signal and the 30 cps variable phase signal are conducted from the detector load through the shielded lead to C-173. This capacitor presents a high reactance to the 30 cps variable phase component but allows the 9960 cps FM signal to pass through with negligible attenuation. Resonant filter Z-102 forms a band-pass filter which permits the 9960 cps component, including its FM side bands, to appear at grid 7 of V-115A. The Q of the circuit is approximately five and is determined primarily by shunt resistor R-164 which is connected across the filter. The filter itself is hermetically sealed and is comprised of a toroidally wound powdered iron core inductor and a highly stable silvered mica capacitor. Because of its pass band characteristics, the action of the filter on the FM signal causes a negligible amount of delay and introduces some amplitude modulation. As will be seen later, this amplitude modulation is not significant since it is followed by severe limiting. Reference amplifier V-115A is a resistance coupled amplifier concerned mainly with the amplification of those frequencies in the vicinity of 9960 cps. It is coupled to grid 2 of the first limiter stage.

5-7. REFERENCE CHANNEL LIMITERS.

The output of reference amplifier V-115A is coupled to the 1st limiter tube V-116 through C-174. Limiter V-116A performs as a cathode follower in conjunction with V-116B which is connected as a grounded grid amplifier. It can be shown that the negative half of the signal impressed at grid 2 will be driven into plate current cut-off by action of the cathode follower section, and the succeeding positive half-cycle will be driven into plate current cut-off by action of the grounded grid amplifier. Thus limiting is achieved without grid current and by completely eliminating any circuit currents proportional to that part of the signal which is undesired. The grounded grid section of V-116 is coupled to the grid of the second limiter V-117 which is a duplicate combination of cathode follower and grounded grid amplifier and performs exactly as V-116. Input to the second limiter is essentially a square wave and its output would approach a perfect square wave were it not for loading effects of the following slope circuit.

5-8. REFERENCE CHANNEL DEMODULATOR.

The distorted square wave output of V-117 is applied to translator amplifier V-118B through coupling capacitor C-176 and an anti-resonant filter section comprised of R-173, an inductor housed within T-112 and tuning capacitors C-177 and C-178. The inductor employed in this anti-resonant filter is toroidally wound on an iron core and has an internal spoiling resistor to decrease the Q of the anti-resonant circuit to a nominal value of 12. The driving impedance of the filter reduces the circuit Q to approximately five. The actual winding resistance contributes very little to the circuit Q, this being primarily determined by the internal shunt resistance and the input impedance. Capacitors C-177 and C-178 are highly stable silvered mica capacitors of such magnitude as to tune the anti-resonant circuit somewhat above 9960 cps. By so doing, the FM spectrum falls on the low frequency side of resonance, on a linear portion of the resonance curve, thus generating amplitude modulation as a function of the deviation ratio and the Q of the circuit. Because of the very effective limiting preceding this circuit the amplitude modulation appearing at grid 7 of V-118B is, for all practical purposes, independent of any propeller modulation or similar amplitude modulation originating at the transmitter. The amplitude modulation envelope is amplified by the translator amplifier and is passed through a linear transformer T-112 where a bridge rectifier CR-101 demodulates the AM signal. Thus a 30 cps signal directly proportional to the deviation ratio on the subcarrier is obtained.

5-9. BRIDGE RECTIFIER AND MANUAL RESOLVER AMPLIFIER.

Capacitor C-179 and resistor R-175 comprise the rectifier filter and load respectively. The rectifier is loaded in addition by resistors R-176 and R-177 which by virtue of their grounded common connection make it possible to obtain two 30 cps signals in phase opposition. The 30 cps reference signal is coupled to the 336A-2 Omni-Bearing Selector resolver rotor by virtue of the cathode follower action of V-115B. Resistor R-178 serves as a swamping resistor to provide constant current resolver input, thus minimizing variations in copper winding resistance of the resolver rotor. The stator outputs of the 336A-2 Omni-Bearing Selector resolver are coupled through tracking control R-180 to terminal 1 of Z-104A and directly to terminal 2 of Z-104A. This provides an RC circuit having

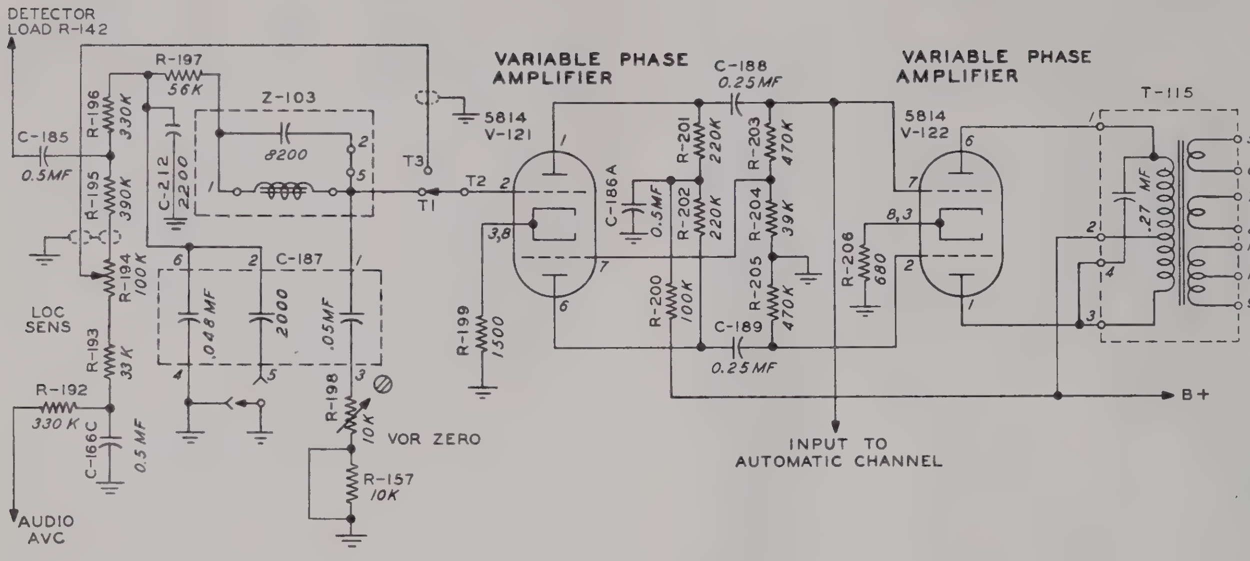

DETECTOR LOAD R-142
R-197
56K
Z-103
VARIABLE PHASE AMPLIFIER
C-188
0.25MF
VARIABLE PHASE AMPLIFIER
T-115
C-185
0.5MF
R-196
330K
8200
2
5
T3
5814
V-121
R-201
220K
R-203
470K
5814
V-122
6
5
6
7
8
11
10
9
R-195
390K
C-212
2200
1
T2 2
T1
C-186A
0.5MF
R-202
220K
R-204
39K
7
8,3
.27 MF
2
3,8
R-194
100K
6
2
C-187
1
.048MF
2000
.05MF
4
5
3
R-206
680
2
4
1
3
7
6
LOC SENS
R-193
33K
R-199
1500
R-200
100K
R-205
470K
C-189
0.25MF
R-192
330 K
R-198
10K
VOR ZERO
C-166C
0.5 MF
B+
INPUT TO AUTOMATIC CHANNEL
R-157
10K
AUDIO AVC

Figure 5-3. Variable Phase Channel Simplified Schematic Diagram

a resistance equal in magnitude to the reactance of the capacitor at a frequency of 30 cps. Resistor R-180 provides the means for establishing this equality. The electrical output at the junction of the first 256,000 ohm resistor and the .02 mf capacitor mounted in Z-104A can be shown to follow in phase angle the mechanical rotation of the rotor which is controlled by the knob on the 336A-2 Omni-Bearing Selector. The second RC section functions as a low pass filter section that eliminates the higher order frequencies coming from the resolver that are accentuated by the constant current excitation of the resolver rotor.

5-10. REFERENCE CHANNEL AMPLIFIERS.

The output of Z-104A is fed to grid 2 of the cascade amplifier, V-119. The signal is amplified in the first section of V-119 and is fed through C-182 to the second section of V-119 where it is further amplified. The unloaded output of the second section of V-119 is coupled through C-183 and R-190 to the anti-resonant transformer T-113. Resistor R-189 provides a feedback loop in conjunction with R-181. The amount of feedback is adjusted by REF PHASE LEVEL potentiometer, R-181. This feedback serves to stabilize the gain through the reference amplifier. Resistor R-190 in conjunction with T-113 serves as a means of establishing a rate of phase angle change versus modulation frequency change and is the prime contributor, in the reference channel, toward establishing overall frequency compensation. A silvered mica capacitor within T-113 tunes the secondary of T-113 to parallel resonance at 30 cps ±1/2% as determined by zero phase shift across R-190. The secondary of T-113 is connected as an autotransformer to provide push-pull excitation for the grids of reference amplifier V-120. Transformer T-114 couples the output of V-120 to the metering circuit. The primary of T-114 is tuned to 30 cps ±1-1/2% in order that variation in plate resistance due to tube interchange can be absorbed with negligible variation in phase angle.

5-11. VARIABLE PHASE CHANNEL. (See figure 5-3.)

The 30 cps variable phase signal is obtained at the arm of potentiometer R-142. This signal is

NOTE: NEGATIVE SIGN PRECEDING V_F INDICATES REVERSED POLARITY OF WINDING CONNECTION

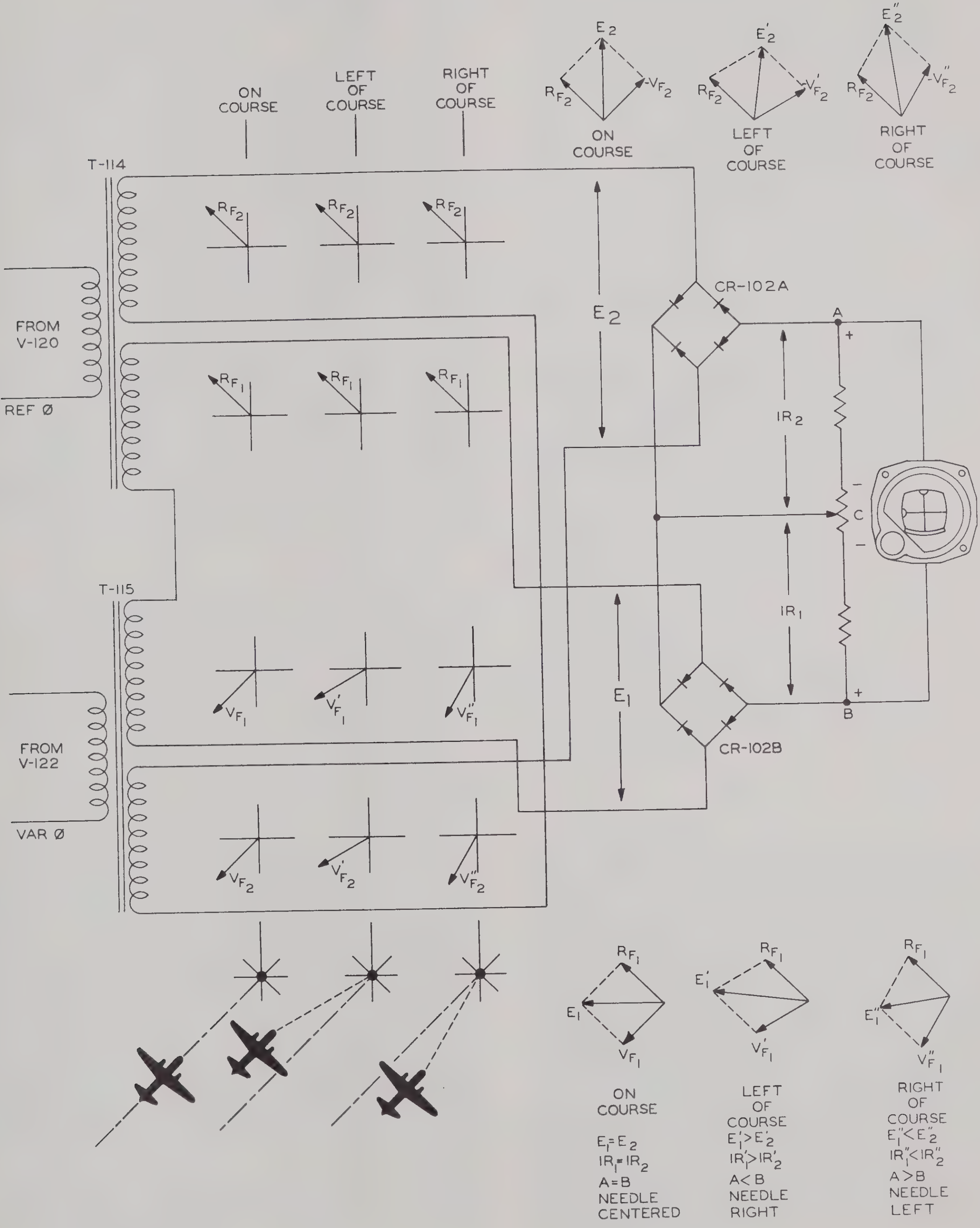

ON COURSE
LEFT OF COURSE
RIGHT OF COURSE
E_2
R_{F_2}
$-V_{F_2}$
ON COURSE
E_2'
R_{F_2}
$-V_{F_2}'$
LEFT OF COURSE
E_2''
R_{F_2}
$-V_{F_2}''$
RIGHT OF COURSE
T-114
R_{F_2}
R_{F_1}
FROM V-120
REF Ø
E_2
CR-102A
A
+
IR_2
−
C
−
IR_1
+
B
CR-102B
T-115
V_{F_1}
V_{F_1}'
V_{F_1}''
FROM V-122
VAR Ø
E_1
V_{F_2}
V_{F_2}'
V_{F_2}''
R_{F_1}
E_1
V_{F_1}
ON COURSE
$E_1=E_2$
$IR_1=IR_2$
A=B
NEEDLE CENTERED
R_{F_1}
E_1'
V_{F_1}'
LEFT OF COURSE
$E_1'>E_2'$
$IR_1'>IR_2'$
A<B
NEEDLE RIGHT
R_{F_1}
E_1''
V_{F_1}''
RIGHT OF COURSE
$E_1''<E_2''$
$IR_1''<IR_2''$
A>B
NEEDLE LEFT

Figure 5-4. Phase Comparator Circuit Operation

coupled through C-185 to a network of resistors comprised of R-193, R-194, R-195, and R-196. Resistor R-196 serves to establish the phase shift vs modulation frequency change characteristic of the following filter circuit made up of Z-103, C-187, R-198, and R-197. Resistor R-197 serves to swamp the variation of winding resistance in Z-103, and thereby reduce phase shift as a function of winding resistance variation to a negligible quantity. Filter Z-103 consists of a stable inductor and a highly stable silvered mica capacitor forming an anti-resonant circuit tuned to 60 cps. Filter Z-103 and capacitor C-187 form a resonant circuit tuned somewhat below 30 cps (approximately 25). Thus a steep attenuation characteristic between 30 cps and frequencies slightly higher is established. This tends to minimize some of the difficulties encountered in aircraft having unwanted propeller modulation in the range of 35 to 40 cps. Resistor R-198 serves as a control over the absolute phase shift through the filter and thus permits continuous variation in phase angle over a range of approximately five degrees. A fixed increment (4 degrees) of phase shift is provided by means of the shorting link on C-187. This adjustment can be with a Spintite wrench. A fixed increment of phase shift in the opposite direction is provided as a factory adjustment by means of R-157. A small amount of forward acting avc is provided through the decoupling circuit, R-192 and C-166C, and is sufficient to establish stable deflection sensitivities over a wide range of r-f signal input.

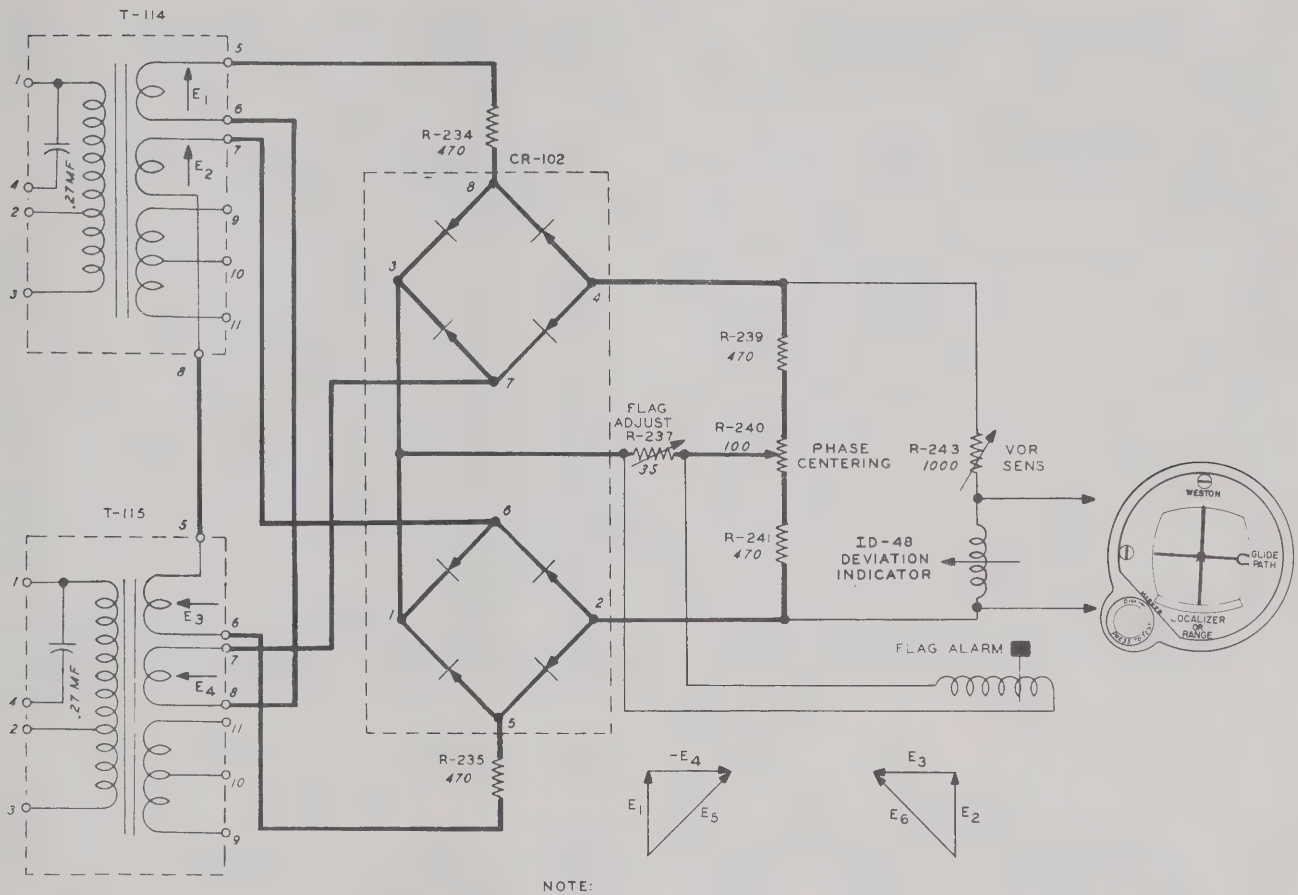
5-12. VARIABLE AMPLIFIER.

Variable amplifier V-121 is a phase inverter stage obtaining excitation from Z-103. The values of capacitors C-188 and C-189, which couple the output of V-121 to the push-pull variable phase amplifier V-122, are such as to discourage amplification of the low frequency products of propeller modulation in the region of 10 to 20 cps. Tube V-122 is a straight amplifier which raises the power level to a suitable magnitude for excitation of the deviation indicator circuit. The power is transferred through T-115 to the phase comparator circuit. The primary of T-115 in VOR operation, is resonated at 30 cps ±1-1/2% by means of an internal 0.27 mfd capacitor so that variations in resistance resulting from tube interchange will produce negligible variation in phase angle. Figure 5-3 shows the circuits obtaining in VOR operation. In localizer operation the internal tuning capacitor is removed from the circuit by means of contacts T10, T11, and T12 of relay K-105.

5-13. MANUAL PHASE COMPARATOR.

The 30 cps reference phase voltage which has been manually shifted in phase by the resolver in the OBS is applied to the primary of T-114. The 30 cps variable phase voltage, the phase of which depends on the omni-bearing, is applied to the primary of an identical transformer, T-115. Figure 5-4 shows a simplified schematic of the manual phase comparison circuit. The lower secondary winding of T-114 is connected in series with the upper secondary of T-115 and the series pair is connected to bridge rectifier, CR-102B. The upper secondary winding of T-114 and the lower secondary winding of T-115 are similarly connected to the other bridge rectifier, CR-102A, except that the connections to the lower secondary winding of T-115 are reversed. Output of the double bridge rectifier CR-102 is applied to a balanced resistance system that sets up two bucking voltages, the difference of which operates the vertical needle meter movement of the deviation indicator.

In figure 5-4 the reference phase voltage, R_f, is shown as the shifted reference phase voltage existing for a MAGNETIC BEARING selection of 45 degrees. This is the omni-bearing that would normally be selected when the aircraft is in position F, figure 4-2. V_f is the variable phase voltage corresponding to position F. In figure 5-4 conditions are shown for the aircraft on-course, left-of-course, and right-of-course. When on course the variable phase voltage V_f is 90 degrees to the shifted phase voltage R_f. E_1 is the sum of R_{f_1} and V_{f_1}, applied to CR-102B. E_2 is the sum of R_{f_2} and $-V_{f_2}$ applied to CR-102A. When on course E_1 and E_2 are equal. Output voltages from CR-102A and CR-102B are equal, point A is at the same potential as B, and no vertical needle deflection exists. When the aircraft is left-of-course the phase of V_{f_1} and $-V_{f_2}$ increases to V_{f_1} and V_{f_2} since the omni-bearing has increased this amount. R_{f_1} and V_{f_1} are now less than 90 degrees apart and when added result in E_1. R_{f_2} and V_{f_2} are more than 90 degrees apart and when added result in E_2 which is less than E_1. Since E_1 is greater than E_2, point B will be at a higher potential than point A, IR_1 will be greater than IR_2, and right needle deflection


T-114
E1
E2
.27 MF
R-234
470
CR-102
R-239
470
FLAG
ADJUST
R-237
35
R-240
100
PHASE
CENTERING
R-243
1000
VOR
SENS
WESTON
GLIDE
PATH
LOCALIZER
OR
RANGE
T-115
E3
E4
.27 MF
R-241
470
ID-48
DEVIATION
INDICATOR
FLAG ALARM
R-235
470
-E4
E1
E5
E3
E6
E2

NOTE:
THE NEGATIVE SIGN PRECEDING E_4 IN THE VECTOR DIAGRAM INDICATES REVERSED POLARITY OF WINDING CONNECTION

Figure 5-5. Phase Comparator Schematic Diagram

results. When the aircraft is right-of-course the opposite set of conditions exists, as shown in figure 5-4, and left needle deflection results.

Figure 5-5 shows the phase comparator and deviation indicator circuit details when switched for VOR operation. Resistor R-240 provides a means of adjusting the metering circuit to eliminate original unbalance currents which may result from sight differences in the two bridges as well as tolerance variation in R-235, R-234, R-241, and R-239. Resistor R-237 creates a small voltage drop, proportional to the percentage of modulation of the signals involved, which is applied to the flag movement of the deviation indicator. It is adjustable for correct VOR flag alarm operation. In the absence of the reference or variable phase signal, the flag alarm will show, indicating that either the airborne or the ground VOR facility is no longer reliable and should not be used. Variable resistor R-243 serves as a sensitivity control for the deviation indicator in VOR channels and is short circuited on localizer channels. It provides an adjustment from a maximum sensitivity of 15 degrees to a minimum sensitivity of approximately 30 degrees.

5-14. TO-FROM INDICATOR CIRCUIT.

The TO-FROM circuit is comprised of rectifiers CR-103, CR-104, load resistors R-231, R-232 and 90° RC phase shift network R-233, C-200. These components are connected to reference and variable channel output transformers T-114 and T-115 as shown in figure 5-6. In the theory of operation discussion, paragraph 4-6, it was pointed out that the shifted reference phase voltage must be given an additional 90° fixed phase shift for operation of the TO-FROM circuit. See figure 5-6. This shift is created by R-233 and C-200. The resistance of R-233 is approximately equal to the reactance of C-200 at 30 cps. The voltages E_6 and E_7 across R-233 and C-200 therefore are equal and add at right angles to give E_5 the phase of which is 90° to the shifted reference phase voltage, E_1, E_2. At cross pointer balance the phase relationship between the shifted reference phase voltage and the variable phase voltage is 90°. This is indicated in figure 5-6 by showing E_3 and E_4 at 90° to E_1 and E_2. The voltage applied to rectifier CR-103 is the vector sum of E_3 and E_5 and is shown as E_9 in figures 5-6 and 5-7. The rectified d-c current due to E_9 causes an IR drop in R-231, with point A negative with respect to C. The voltage applied to rectifier CR-104 is the vector sum of E_4 and E_5 and is shown as E_8 in figures 5-6 and 5-7. The rectified d-c current due to E_8 causes an IR drop in R-232 with point B negative with respect to C. The algebraic sum of the d-c voltages across R-232 and R-231 is applied to the TO-FROM meter movement of the deviation indicator. When point B is more negative than A the indication is FROM. When point A is more negative than B the indication is TO. Figure 5-7 shown the vector relations that exist for both TO and FROM indications when on course and when slightly off course. It should be noted from figure 5-7 that great accuracy in the TO-FROM phase comparator is not necessary since only an approximate in-phase or out-of-phase relationship between E_5 and E_3, E_4 is required to operate

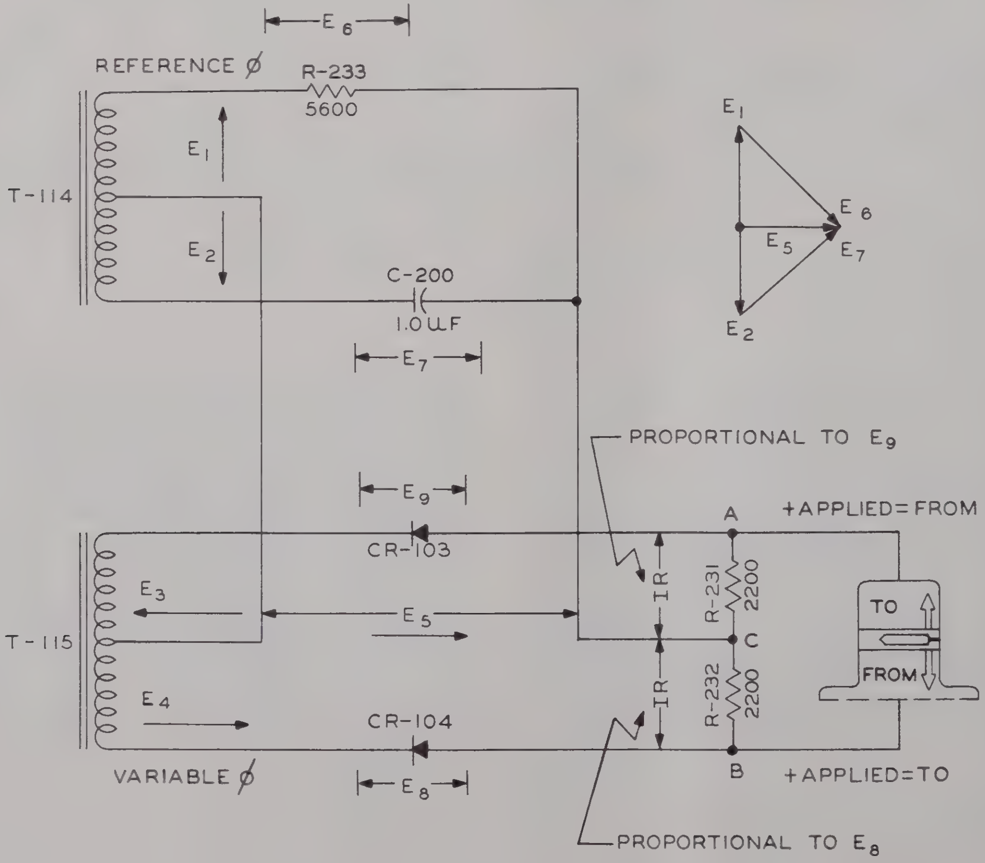


Figure 5-6. TO-FROM Circuit Operation

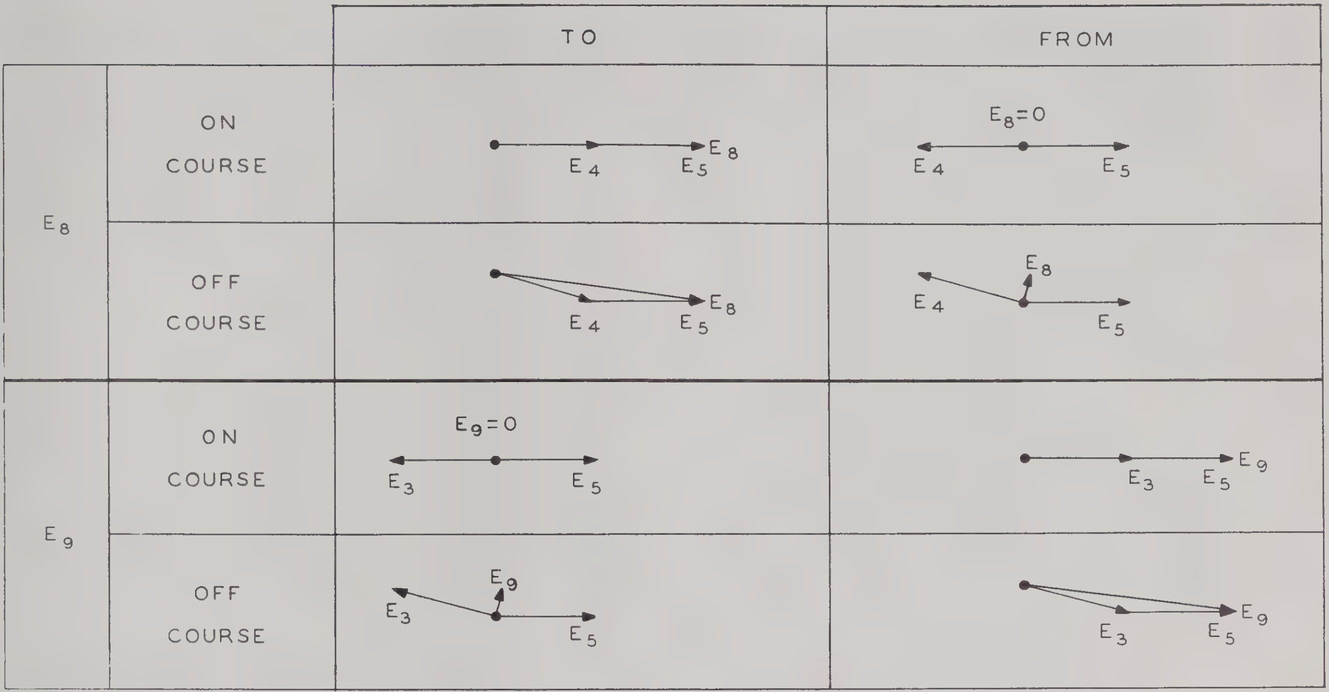


Figure 5-7. TO-FROM Circuit Voltage Additions

the TO-FROM meter movement satisfactorily. It is also interesting to note that when the aircraft is located on a line perpendicular to the COURSE selected and passing thru the omnirange, E_8 and E_9 are equal and no TO-FROM indicator deflection exists.

5-15. AUTOMATIC RESOLVER AMPLIFIER AND AUTOMATIC RESOLVER.

A 30 cps signal, 180 degrees out of phase with the reference phase signal supplied to the manual resolver amplifier, is applied to the automatic resolver amplifier, V-118A, through coupling capacitor C-181. Refer to figure 5-8. The signal is amplified by V-118A and coupled through R-179 to the automatic resolver rotor located in the OBI. Resistor R-179 serves as a swamping resistor to provide constant current input to the resolver, thus minimizing variations in the winding resistance of the resolver rotor. The stator windings of the automatic resolver are connected to an RC circuit in which the resistance is equal to the reactance of the capacitor. AUTO TRACKING control, R-207, provides a means of establishing this equality. The electrical output of test point B of Z-104B can be shown to follow in phase angle the mechanical rotation of the automatic resolver rotor. The second RC section of Z-104B functions as a low pass filter to eliminate the higher order frequencies generated by the automatic resolver and accentuated by the constant current excitation of the resolver rotor.

5-16. AUTOMATIC VOLTAGE AMPLIFIER.

The signal is amplified by resistance coupled amplifier V-123A and fed to the grid of V-123B through coupling capacitor C-190. Part of the output is fed through R-210 to the cathode of V-123A to stabilize the gain of the automatic voltage amplifier. Capacitor C-191 couples the signal through R-215 to the grid of the automatic phase detector. Transformer T-116, operating as an auto-transformer, is connected between the grids of V-124 and is tuned to resonance at 30 cps ±1/2 percent by means of a capacitor located within its case. The center tap of T-116 is connected to a-c ground through the low reactance of C-166B. It can be shown that the opposite ends of the tuned circuit consisting of T-116 and its capacitor have a 180 degree phase relationship. Consequently,

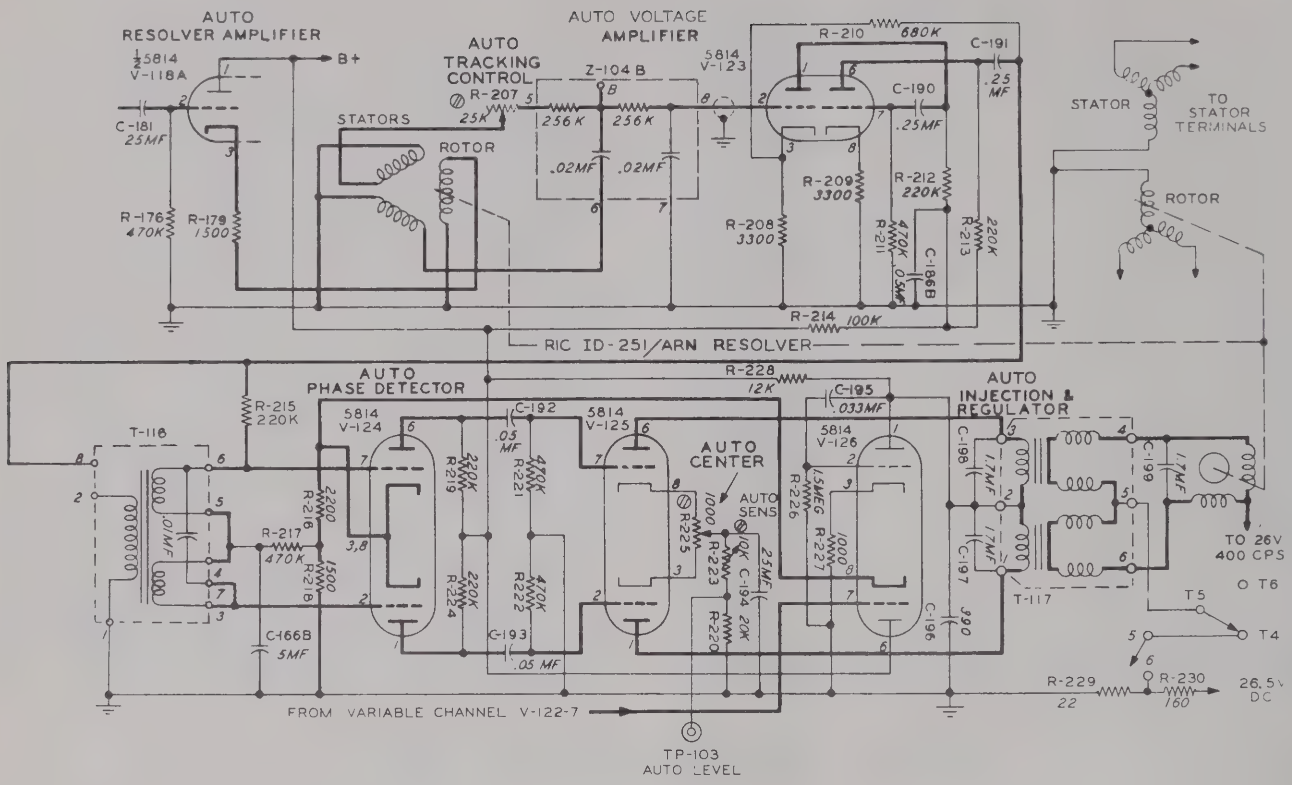

AUTO RESOLVER AMPLIFIER
½5814 V-118A
B+
C-181 25MF
R-176 470K
R-179 1500
AUTO TRACKING CONTROL
R-207 25K
STATORS
ROTOR
AUTO VOLTAGE AMPLIFIER
Z-104 B
256K
256K
.02MF
.02MF
5814 V-123
R-210 680K
C-191 .25 MF
C-190 .25MF
R-209 3300
R-208 3300
R-212 220K
R-211 470K
C-186B .05MF
R-213 220K
R-214 100K
RIC ID-251/ARN RESOLVER
STATOR
TO STATOR TERMINALS
ROTOR
AUTO PHASE DETECTOR
R-215 220K
T-116
5814 V-124
R-216 2200
R-217 470K
R-218 1500
C-166B 5MF
R-219 220K
R-224 220K
C-192 .05 MF
R-221 470K
R-222 470K
C-193 .05 MF
R-228 12K
5814 V-125
AUTO CENTER
R-225 1000
AUTO SENS
R-223 10K
C-194 25MF
R-220 20K
C-195 .033MF
5814 V-126
R-226 1.5MEG
R-227 1000
C-196 .990
AUTO INJECTION & REGULATOR
C-198 1.7MF
C-197 1.7MF
C-199 1.7MF
T-117
TO 26V 400 CPS
T5
T6
T4
R-229 22
R-230 160
26.5V DC
FROM VARIABLE CHANNEL V-122-7
TP-103 AUTO LEVEL

Figure 5-8. Automatic Circuit Simplified Schematic

the grids of V-124 are excited by voltages 180 degrees out of phase with each other as a result of the phase inverting action of T-116.

5-17. AUTOMATIC PHASE COMPARATOR CIRCUIT.

The variable phase signal from the variable phase amplifier, V-122, is amplified in the automatic injection stage, V-126. The signal is coupled through common cathode resistors R-216 and R-218 to the cathode of phase detector, V-124. Resistor R-217 and by-pass capacitor C-166B provide approximately 34 db attentuation between the cathode and grid circuits of V-124. Consequently, for all practical purposes, the signal on the cathodes is isolated from the grid circuits. The signals are mixed by virtue of their common cathode currents resulting in two plate currents proportional to the magnitude and phase relationship of the applied voltages. Coupling capacitors C-192 and C-193 feed the two signals to the grids of automatic reactor control, V-125. V-125 amplifies the signals and provides a method through R-225 (AUTO CENTERING), of adjusting the relative magnitudes of the two signals. The amplified signals are applied to saturable reactor T-117. Reactor T-117 is coupled to a two-phase motor located in the OBI and to a 26-volt 400-cps source. The signals at the plates of V-125 vary in relative amplitude. Thus, when the signal at pin 6 of V-125 is the larger, the top portion of reactor T-117 is driven into saturation, reducing the output of the top half of the secondary and causing the motor to rotate in one direction. When the signal at pin 1 of V-125 is larger, the lower half of T-117 is saturated, reducing the output of the lower half of the secondary and causing the motor to rotate in the opposite direction. Capacitor C-199 provides the 90 degree phase shift necessary for operation of the two phase motor. This circuit operates in a manner similar to that of the 333B-1 Servo Amplifier described in paragraph 4-9. Potentiometer R-223 (AUTO SENS) allows adjustment of V-125 plate currents to secure satisfactory operation of saturable reactor T-117. Resistors R-229 and R-230 provide eddy current damping in the motor stator winding thus minimizing any tendency toward hunting. Means are provided for disabling the OBI by opening the circuit between R-229 and pin 5 of T-117. Switching is provided for this function through contacts 5 and 6 of the megacycle Autopositioner switch, S-102, and contacts T4 and T5 of K-105. This circuit is closed for frequencies assigned to omni-range reception.

5-18. VECTOR RELATIONS.

To illustrate more clearly the actual operation of the phase comparator circuits refer to the vector diagram, figure 5-9. Figure 5-9 A illustrates the vector diagram which might be obtained in a balanced condition (OBI reading the correct omni-bearing). The two vectors E_{43} and E_{56} represent the voltages developed across terminals 4 to 3 and 5 to 6, respectively, of transformer T-116. This voltage represents output of the automatic resolver in the OBI. In the balanced condition, the voltage which is obtained from the variable phase amplifier and mixed at the cathode circuit of V-124, is displaced 90 degrees from the two reference voltage. This results in E_1 and E_6 at the plates, pins 1 and 6, of V-124. These voltages are applied to the grids of V-125 where they serve as plate current control to the saturable reactor T-117. Since both voltages are equal in magnitude, equal currents result, the motor does not rotate, and the balanced condition is maintained. When the aircraft moves around the station a few degrees, the variable phase voltage E_V rotates slightly to the new position shown in figure 5-9B. As can be seen from the diagram, the resultant vector, E_6, is now considerable larger than the other resultant vector, E_1. These unequal signals are applied to the grids of V-125 causing an increase in plate current in the section which receives the larger signal. The increase in plate current causes the control winding of one of the reactors T-117 to become saturated, reducing the impedance of the corresponding a-c control winding and allowing the motor to rotate in the desired direction. The motor rotates the automatic resolver rotor which, in turn, rotates the phase of the two reference phase vectors, E_{43} and E_{56}. The motor continues to rotate until the reference phase vectors (E_{43} and E_{56} are in phase quadrature with the variable phase vector (E_V). This positions the dial on the OBI to indicate the proper omnibearing. Figure 4-6 will aid in visualizing this operation. The new balance condition attained is shown in figure 5-9C.

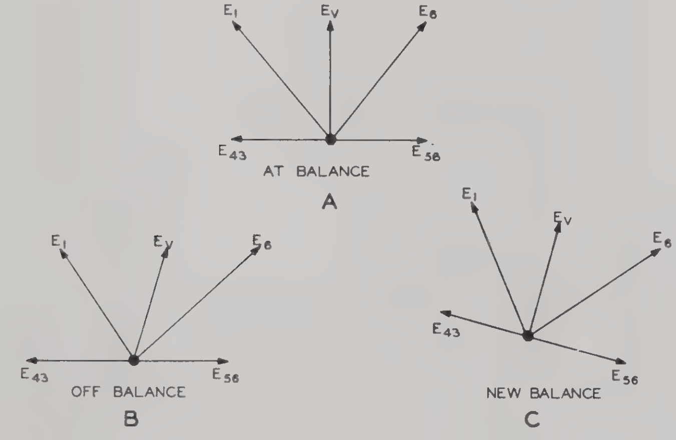


Figure 5-9. Automatic Circuit Vector Diagrams

5-19. AUTOMATIC REGULATOR.

Refer to figure 5-8. Plate power for V-125 and V-126A must flow through R-228. By coupling the surges which appear at V-126 due to the power requirements of V-125 back into the grid circuit of V-126, equal surges of opposite phase flow through V-126. Thus, the overall effect of the reactor control on the B+ of the receiver is minimized, resulting in improved accuracy and elimination of B+ modulation of the receiver portion of the equipment. Capacitor C-195 and resistor R-226 provide the necessary feedback for this function. Capacitor C-196 serves as a high frequency shunt circuit on the regulator section of V-126 to prevent possible spurious oscillation.

5-20. LOCALIZER SECTION.

Certain circuits, previously discussed in connection with omni-range operation, are used in providing the localizer function. The frequency selecting circuits automatically connect the various circuits to receive either omni-range or localizer signals. The circuit diagrams which follow are simplified diagrams showing only the circuit relative to the localizer operation.

Refer to figure 5-10. The composite 90 and 150 cps signal from detector load resistor R-142 is coupled through C-185 and R-194 to the grid of phase inverter V-121. Potentiometer R-194, LOC SENS, allows adjustment of the input signal.

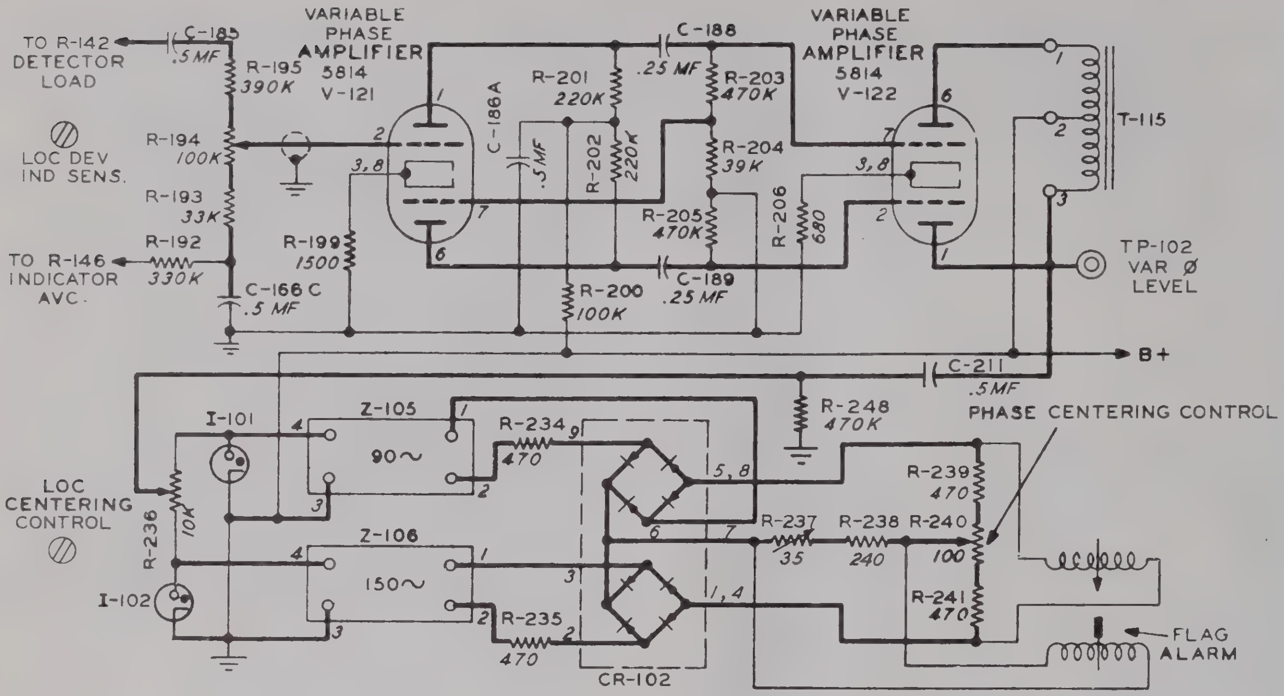

TO R-142 DETECTOR LOAD
C-185 .5 MF
R-195 390K
VARIABLE PHASE AMPLIFIER 5814 V-121
C-188 .25 MF
VARIABLE PHASE AMPLIFIER 5814 V-122
T-115
LOC DEV IND SENS.
R-194 100K
R-193 33K
R-192 330K
TO R-146 INDICATOR AVC.
C-166 C .5 MF
R-199 1500
C-186A .5MF
R-201 220K
R-202 220K
R-203 470K
R-204 39K
R-205 470K
R-206 680
R-200 100K
C-189 .25 MF
TP-102 VAR Ø LEVEL
B+
C-211 .5MF
R-248 470K
PHASE CENTERING CONTROL
I-101
Z-105 90~
R-234 470
LOC CENTERING CONTROL
R-236 10K
I-102
Z-106 150~
R-235 470
CR-102
R-237 35
R-238 240
R-239 470
R-240 100
R-241 470
FLAG ALARM

Figure 5-10. Localizer Simplified Schematic, On Course

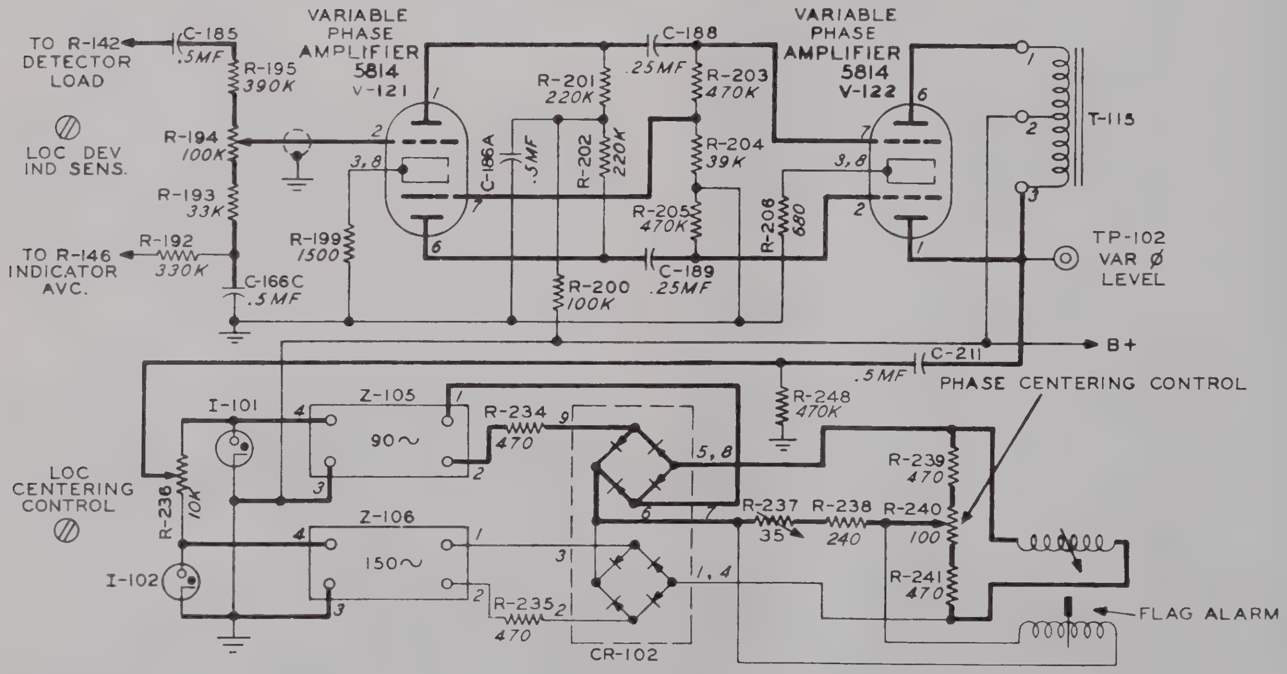

TO R-142 DETECTOR LOAD
C-185 .5MF
R-195 390K
VARIABLE PHASE AMPLIFIER 5814 V-121
C-188 .25MF
VARIABLE PHASE AMPLIFIER 5814 V-122
T-115
LOC DEV IND SENS.
R-194 100K
R-193 33K
R-192 330K
TO R-146 INDICATOR AVC.
C-166C .5MF
R-199 1500
C-186A .5MF
R-201 220K
R-202 220K
R-203 470K
R-204 39K
R-205 470K
R-206 680
R-200 100K
C-189 .25MF
TP-102 VAR Ø LEVEL
B+
C-211 .5MF
R-248 470K
PHASE CENTERING CONTROL
I-101
Z-105 90~
R-234 470
LOC CENTERING CONTROL
R-236 10K
I-102
Z-106 150~
R-235 470
CR-102
R-237 35
R-238 240
R-239 470
R-240 100
R-241 470
FLAG ALARM

Figure 5-11. Localizer Simplified Schematic, Left of Course

Capacitors C-188 and C-189 couple the signal to the grids of push-pull amplifier V-122. The output of V-122 appears across the primary of T-115 and is impressed across the paralleled inputs of 90 and 150 cps filters, Z-105 and Z-106, respectively. Output of V-122 appearing across T-115 is connected to the arm of LOC CENTERING control R-236. Potentiometer R-236 permits adjustment of the balance point of the deviation indicator to compensate for variations in component tolerances. Neon discharge lamps, I-101 and I-102, will ionize and short circuit any surges present in the filter input, thus protecting the filters from damage. The outputs of the 90 and 150 cps filters are connected across the double bridge rectifier, CR-102. The output of the rectifier is used to deflect the vertical needle of the deviation indicator. A voltage drop will be developed across R-237 and R-238 as long as the 90 and 150 cps filters are delivering proper signals. This voltage operates the flag alarm on the deviation indicator. If either or both of the two tones should fail, the flag alarm will indicate to the pilot that the localizer function is inoperative.

5-21. ON COURSE-OFF COURSE CONDITIONS.

Figure 5-10 shows the on course condition. When the aircraft is on course, the 90 and 150 cps signals are equal in amplitude. Consequently, the voltage at terminals 5 and 8 and the voltage at terminals 1 and 4 of CR-102 are equal and no difference in potential exists to deflect the vertical needle of the deviation indicator. Figure 5-11 shows the conditions resulting when the aircraft is left on course and figure 5-12 illustrates the conditions existing when the aircraft is right of course. If the aircraft is off course to either the right or left, a difference in amplitude exists between the 90 and 150 cps signals. This causes a difference in potential between terminals 1 and 4 and terminals 5 and 8 of CR-102. This potential difference causes the vertical needle of the deviation indicator to deflect either right or left depending upon the polarity of the voltage.

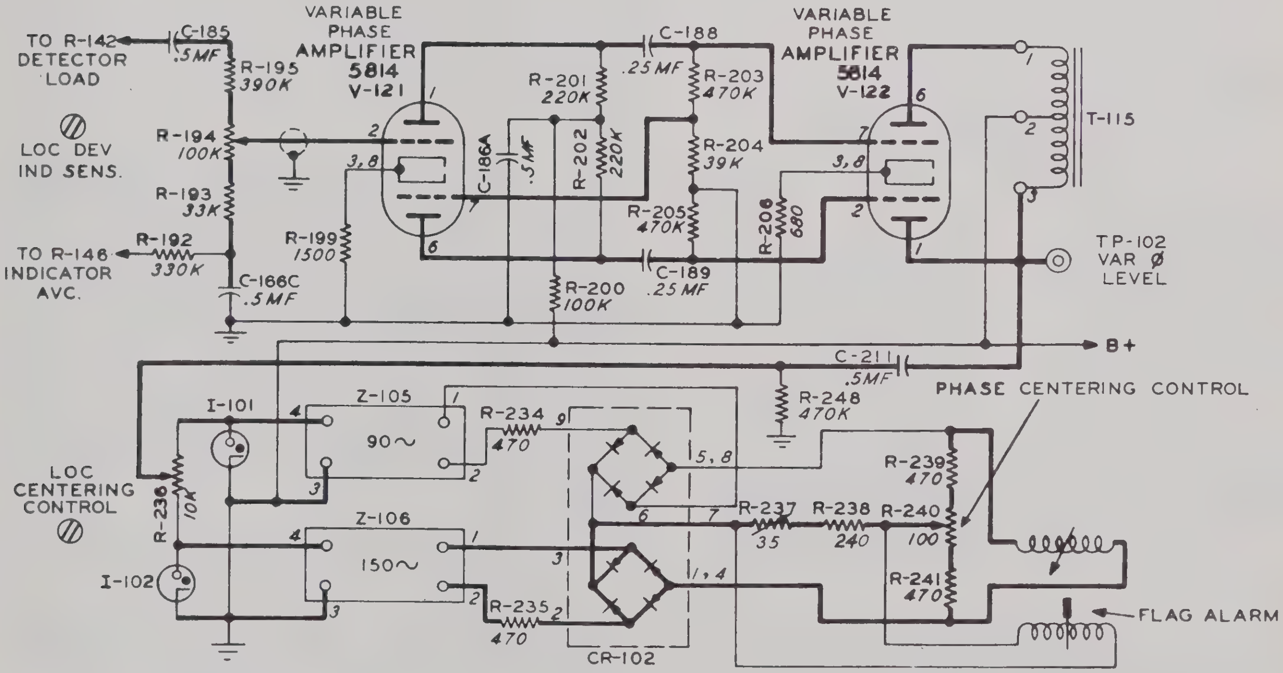

TO R-142 DETECTOR LOAD
C-185 .5MF
R-195 390K
VARIABLE PHASE AMPLIFIER 5814 V-121
LOC DEV IND SENS.
R-194 100K
R-193 33K
TO R-146 INDICATOR AVC.
R-192 330K
C-166C .5MF
R-199 1500
C-186A .5MF
R-201 220K
R-202 220K
C-188 .25MF
R-203 470K
R-204 39K
R-205 470K
R-206 680
C-189 .25MF
R-200 100K
VARIABLE PHASE AMPLIFIER 5814 V-122
T-115
TP-102 VAR Ø LEVEL
B+
C-211 .5MF
R-248 470K
PHASE CENTERING CONTROL
I-101
Z-105
90~
R-234 470
LOC CENTERING CONTROL
R-236 10K
Z-106
150~
I-102
R-235 470
CR-102
5, 8
1, 4
R-237 35
R-238 240
R-239 470
R-240 100
R-241 470
FLAG ALARM

Figure 5-12. Localizer Simplified Schematic, Right of Course

SECTION 6

ALIGNMENT AND TESTING

6-1. INTRODUCTION.

This section contains all the procedural steps necessary to align the equipment and test it for correct functioning. A set of typical test data is included to serve as a standard of performance.

6-2. TEST EQUIPMENT.

A list of test equipment required for alignment and testing of 51R receivers appears below:

R-F Signal Generator - Boonton Model 211-A, SG-1/ARN

Audio Signal Generator - Collins 479S-3, 479S-2, 479S-1

Signal Generator -

Frequency Range: 2 mc to 22 mc
Frequency Accuracy: ±0.5%
Output Voltage: Continuously variable 0.1 microvolts to 2.2 volts.
Output Impedance: 5 to 50 ohm

A. C. Vacuum Tube Voltmeter -

Frequency Range: 10 to 15,000 cps
Voltage Range: .001 to 100. volts rms
Input Impedance: 500,000 ohms, 30 mmf

D. C. Vacuum Tube Voltmeter -

Functions: D. C. Voltmeter, Ohmmeter
Input Impedance: 10 megohms
Ranges: 3. to 5. volts full scale and three higher ranges to 300 volts

Oscilloscope -

Input Impedance: 2 megohms or more, 25 mmf or less
Frequency Characteristic: Uniform from 20 to 20,000 cps.

Audio Oscillator -

Frequency Range: 20 to 15,000 cps
Output: 1. volt

Cathode Follower and 30 cps Filters -

(See text below).

6-3. TEST EQUIPMENT CALIBRATION.

The following procedure presupposes that it is desired to set up the 479S-3 Signal Generator so as to make available standard signals for VOR and localizer without readjustment, when changing signals.

Two modulation levels are involved in this procedure, namely, 30% and 20%. It is essential that the modulation meter reading of the Boonton signal generator be known for these levels. Thirty percent is full scale on the B scale, and may be depended upon to be accurate. Similarly, the 20% reading will be sufficiently accurate on the meter.

Signal levels are variable on CAL position of the FUNCTION SELECTOR by means of the screw driver adjustment, located behind the access door on the front panel of the 479S-3 Signal Generator. Once set, these levels remain constant and need be checked only occasionally. For variable output levels in special testing work, the SPECIFIC SIG position and the MASTER ATTENUATOR control of the 479S-3 Signal Generator should be used. Use of the MASTER ATTENUATOR control does not disturb the calibration made in the CAL position.

6-4. CALIBRATION OF VOR SIGNALS.

Normal VOR modulation consists of a 30% 9960 cps FM signal and a 30% 30 cps signal which is rotatable in phase angle with respect to the 30 cps derived from the 9960 FM. These two 30 cps voltages are in-phase on a radial emanating on a magnetic north bearing from the station.

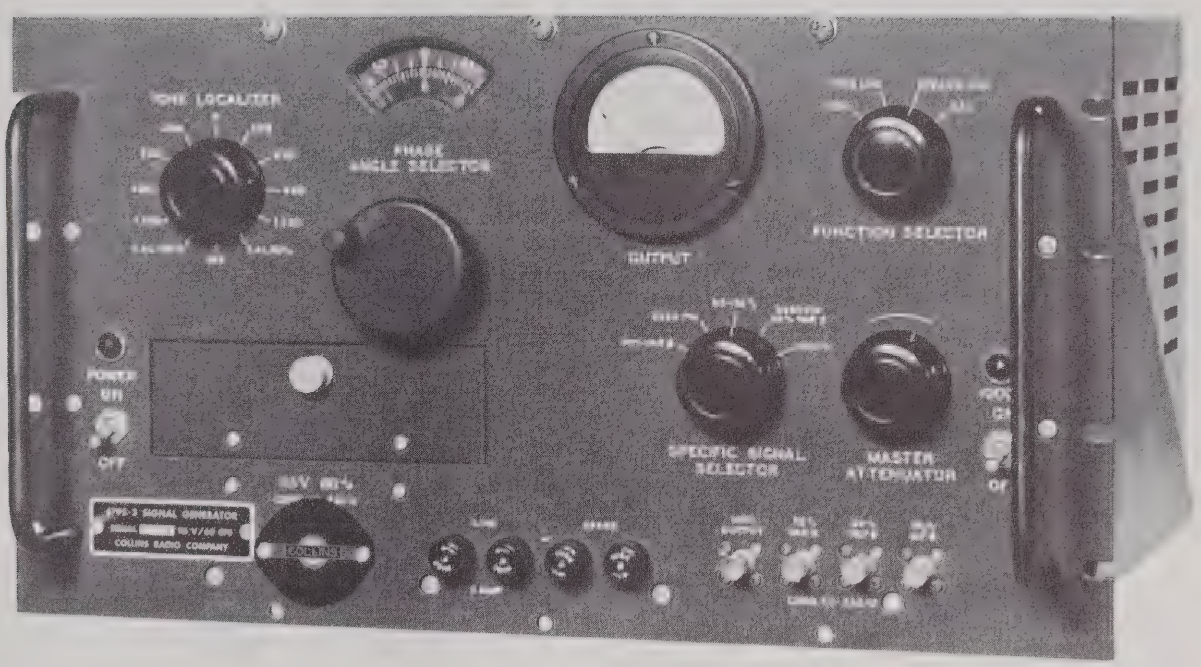

VOR LOCALIZER
PHASE ANGLE SELECTOR
OUTPUT
FUNCTION SELECTOR
POWER ON
OFF
SPECIFIC SIGNAL SELECTOR
MASTER ATTENUATOR
479S-3 SIGNAL GENERATOR
COLLINS RADIO COMPANY
COLLINS

Figure 6-1. Type 479S-3 Signal Generator

PRELIMINARY STEPS

a. Select the scale on the PER CENT MODULATION meter of the 211-A Signal Generator which gives a full-scale reading for 30% modulation.

b. Reduce the MOD LEVEL control of the 211-A to zero or full counterclockwise to prevent damage to the modulation meter in case of excessive input voltage.

c. Connect cable from Modulator Output jack to the input jack of the 211-A.

d. Rotate FUNCTION SELECTOR of the 479S-3 Signal Generator to the position marked CAL.

e. Open potentiometer door on front panel of 479S-3.

f. Insure that 1000 cps toggle switch is in OFF position.

30 CPS VAR ϕ CALIBRATION.

a. Rotate SPECIFIC SIGNAL SELECTOR to position marked 30 cps VAR ϕ .

b. With a screwdriver, adjust the potentiometer marker 30 CPS VAR ϕ until the output meter indicates 1.5 volts.

c. Lock the potentiometer shaft and check the output meter to see that the reading has not changed.

d. Adjust the MOD LEVEL control of the 211-A to read full scale or 30% on the PER CENT MODULATION meter. This setting is now fixed and should not require adjustment.

9960 FM CALIBRATION:

a. Rotate SPECIFIC SIGNAL SELECTOR to position marked 9960 FM.

b. Adjust the potentiometer marked 9960 FM until the PER CENT MODULATION meter again reads full scale.

c. Lock the potentiometer shaft and check the PER CENT MODULATION meter to see that the reading has not changed.

d. A normal omni-range signal may now be obtained by rotating the FUNCTION SELECTOR to the position marked ODR. However, the 100% scale of the PER CENT MODULATION meter of the 211-A should be selected first.

90 CPS CALIBRATION.

a. With FUNCTION SELECTOR in the CAL position, rotate the SPECIFIC SIGNAL SELECTOR to the position marker 90-150 ∼.

b. Rotate the TONE LOCALIZER switch to the position marked CAL 90 cps.

c. With the scale of the PER CENT MODULATION meter on the 211-A selected to read 30% full scale and the MOD LEVEL control set as in 30 ∼ VAR φ calibration, adjust the potentiometer marker 90 CPS until the PER CENT MODULATION meter reads 20%.

d. Lock the potentiometer shaft and check the PER CENT MODULATION meter to see that the reading has not changed.

e. Read the 90 cps voltage carefully on the OUTPUT meter as the 150 cps signal must be set to precisely the same value as shown below.

150 CPS CALIBRATION.

a. Rotate the TONE LOCALIZER switch clockwise to the position marked CAL 150 ∼.

b. Reading the voltage on the OUTPUT meter, adjust the potentiometer marked 150 CPS until the reading is exacly equal to the 90 CPS reading.

CAUTION

This adjustment of equal voltages should be made accurately since small unbalances in these voltages will likely result in incorrect calibration of the tone localizer facility of the 51R-3 receivers.

c. Lock the potentiometer shaft and check to see that the OUTPUT meter reading has not changed.

d. Recheck both the 90 cps and 150 cps voltages to insure that the balance condition is present.

e. Proper tone localizer signals may now be obtained by selecting the 100% scale of the PER CENT MODULATION meter of the 211-A and rotating the FUNCTION SELECTOR to the position marked TONE LOC. The TONE LOCALIZER switch may now be rotated to the position desired for accurate checking or calibration of receivers.

NOTE

The 479S-3 OUTPUT meter deflection is proportional to the average value of a wave whereas the PER CENT MODULATION meter of the 211-A deflects in proportion to the peak value of a wave. Use of the 479S-3 meter for balance of the tone localizer voltages is recommended over the peak-reading meter as it is less susceptible to errors due to small harmonics.

1000 CPS CALIBRATION.

a. With the FUNCTION SELECTOR in the CAL position, rotate the SPECIFIC SIGNAL SELECTOR to the position marked 1000 ∼.

b. With the scale of the PER CENT MODULATION meter on the 211-A selected to read 30% full scale and the MOD LEVEL control set as in 30 ∼ VAR φ calibration, adjust the potentiometer R-128 marked 1000 ∼ until the PER CENT MODULATION meter reads the percentage of modulation desired.

c. Lock the potentiometer shaft and check the PER CENT MODULATION meter to see that the reading has not changed.

d. Select the 100% scale of the PER CENT MODULATION meter on the 211-A.

e. This signal may be superimposed upon any other signal presented at the MOD OUTPUT connector by throwing the 1000 ∼ toggle switch to the ON position.

CAUTION

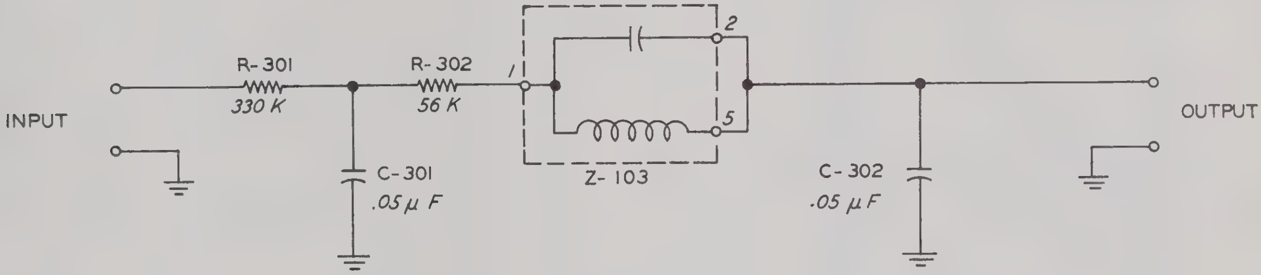
A pilot light is provided to remind the operator that the 1000 cps signal is present at the MOD OUTPUT jack. Where the 1000 cps signal is not desired, the operator must be aware of the warning service provided by this light.

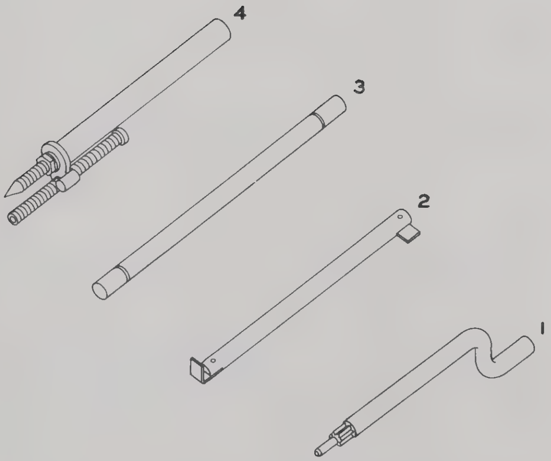
OTHER ADJUSTMENTS.

Variable level is obtained by rotating the FUNCTION SELECTOR to position marked SPECIFIC SIG., and selecting the desired signal by rotating the SPECIFIC SIGNAL SELECTOR. The level of each signal except the tone localizer frequencies may be varied from 0 to approximately 3 volts by turning the MASTER ATTENUATOR. If the 90 cps and 150 cps calibration has been done as previously explained, each of these frequencies may be varied from 0 to approximately 2 volts with the MASTER ATTENUATOR.

If more 90 cps or 150 cps voltage is desired, the 90 cps and 150 cps potentiometers behind the access door may be turned upon unlocking the shafts. However, the operator should be aware that he is destroying the calibration of the tone localizer facility as normally used in receiver testing and he should calibrate this function again before using the modulator for such testing.

30 ~ FILTER FOR OSCILLOSCOPE





QTY	SYM NO.	VALUE	PART NO.
1	R-301	330K	748 0051 00
1	R-302	56K	745 1160 00
2	C-301, 302	.05MFD	912 0767 00
1	Filter Z-103		678 0364 00
1	R-303	1500	745 1093 00

CATHODE FOLLOWER

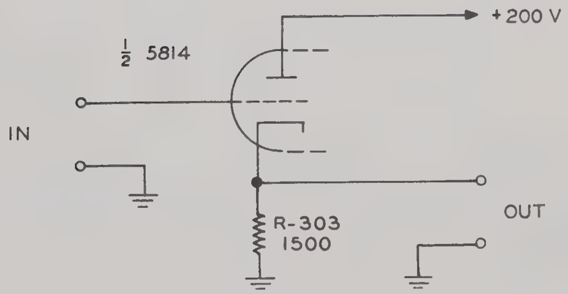


Figure 6-2. Special Tools and Equipment

When selecting the 1000 cps signal by itself, it is not necessary to throw the 1000 toggle switch to the ON position.

CAUTION

It is possible to overload the 3 volt output meter (M-101) on the front panel when the function selector (S-102) is in the position marked specific sig. This can be done by superimposing the 1000 cps signal on another signal or by calibrating the localizer frequencies at a high voltage and then rotating the tone localizer (S-101) to one of the decibel steps. The operator must be aware of this and keep such occurrences to a minimum.

6-5. SPECIAL TOOLS.

The special tools used in the alignment of 51R-3 receivers are listed below and illustrated in figure 6-2.

6-6. FIXED I-F AMPLIFIER ALIGNMENT.

The fixed i-f amplifier transformers, T-105, T-106, T-107 and T-108 are slug tuned. The primary tuning is at the top of the transformer and the secondary tuning at the bottom. Proper alignment requires swamping or loading the transformer secondary while tuning the primary, and loading the primary while tuning the secondary. The swamping tool is used as the load. This combination of resistor and capacitor is connected with the capacitor on the ground end. Observe the stage-by-stage gain as the stages are progressively aligned.

a. Connect the dc vacuum tube voltmeter across the diode load potentiometer, DETECTOR LEVEL (R-142).

b. Connect the swamping tool between the plate of V-107, pin 5, and the chassis. The swamping tool consists of a 4700 ohm 1/2 watt resistor (Collins part number 745 1114 00) and a 2000 mmf capacitor (Collins part number 913 0871 00) in series. No substitute for the swamping tool is recommended as the length of the leads of the resistor and capacitor are quite critical.

SPECIAL TOOLS REQUIRED FOR MAINTENANCE

Figure Index	Collins Part No.	Name	Application
1	505 2059 001	Autopositioner Crank	Manually position Autopositioner
2	504 6027 002	Alignment Tool	Adjust Condenser C-140
3	504 6016 001	Tuning Wand	Alignment
4	505 3491 002	Swamping Tool	Swamping Fixed I-F Transformers

c. Couple the output of the signal generator to the grid of V-107, pin 1, thru a 2000 mmf capacitor.

d. Tune the signal generator to 3.15 mc and adjust its output for a low reading on the vacuum tube voltmeter.

e. Tune the secondary of transformer T-108 for maximum diode load voltage. See figure 6-3 for location of transformers.

f. Remove the swamping tool from the primary of T-108 and connect it across the secondary of the same transformer, pins 4 and 6 of T-108.

g. Tune the primary of T-108 for maximum diode load voltage. This completes the alignment of the 3rd fixed i-f amplifier.

h. Repeat steps b. through g. above, for T-107, T-106, and T-105 with the vacuum tube voltmeter now connected to the avc line.

i. When alignment of the fixed i-f amplifier stages has been completed check to determine if the response is uniform on both sides of 3.15 mc by varying the output frequency of the signal generator on both sides of 3.15 mc and observing the variation in avc voltage.

VARIABLE I-F AMPLIFIER ALIGNMENT.

Transformers T-103, T-104 and T-110 are slug tuned with powdered iron slugs suspended from a table that can be raised or lowered. The alignment consists of positioning the slugs with respect to the position of the table. See figures 6-3, 6-4 for location of the alignment points.

a. Operate the tenth megacycle Autopositioner to 0.9 mc.

b. Tune the signal generator to 20.35 mc.

c. Couple the output of the signal generator to the grid of V-104, pin 1, through a 2000 mmf capacitor using short coaxial leads. Connect the vacuum tube voltmeter to the avc line.

d. Tune the signal generator until the voltmeter indicates maximum avc voltage.

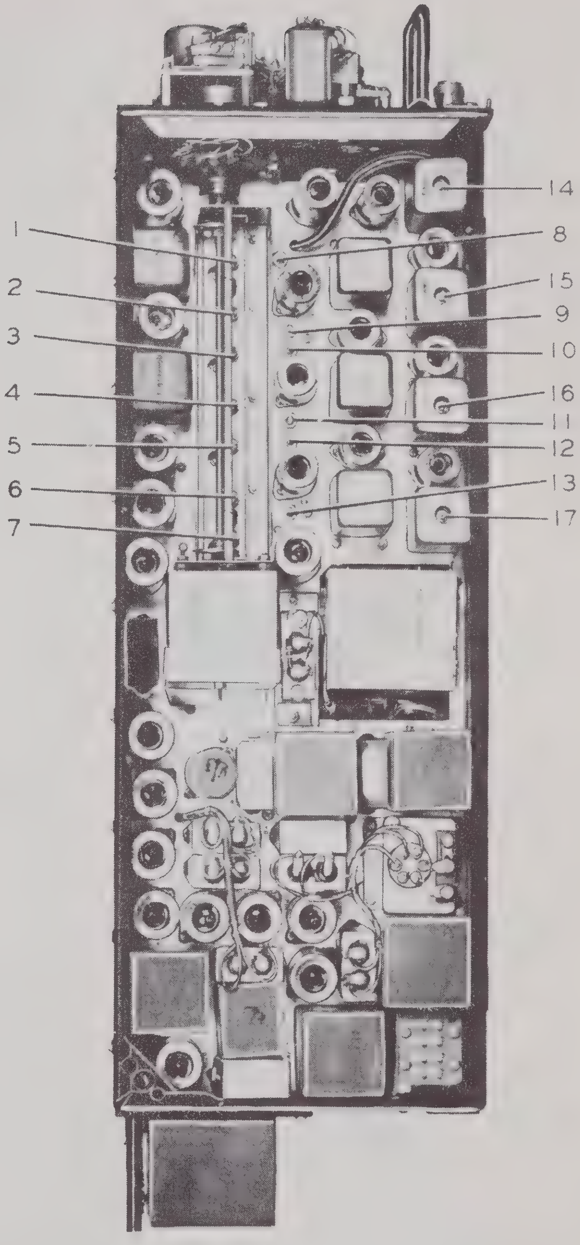
e. Tune both slugs in T-110 for maximum avc voltage.

f. Couple the output of the signal generator to the grid of V-103, pin 1, and tune T-104 for maximum avc voltage.

g. Couple the output of the signal generator to the grid of V-102, pin 1, and tune the slugs in T-103 and T-104 for maximum avc voltage.

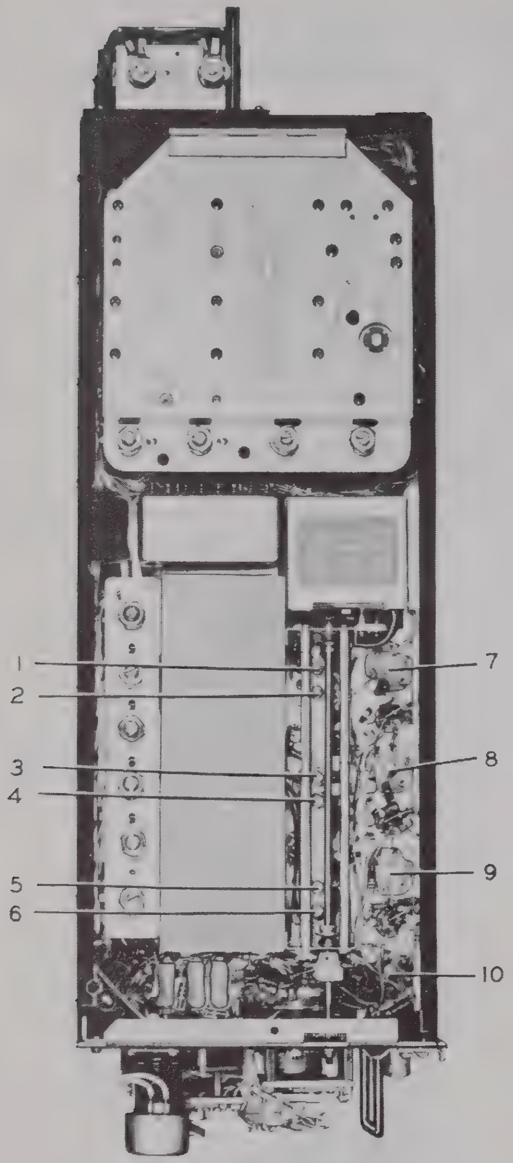
h. Check overall sensitivity of the i-f amplifier, both variable and fixed. Check results against the typical sensitivity measurements given in paragraph 6-10 of this section.

i. Operate the tenth megacycle Autopositioner to the 0.0 position. Apply a 19.45 mc signal to the grid of V-102, pin 1, and check the sensitivity.



(1) T-101 secondary (grid)
(2) T-102 primary (plate)
(3) T-102 secondary (grid)
(4) T-111 secondary (grid)
(5) T-111 primary (plate)
(6) T-118 secondary (grid)
(7) L-102
(8) C-101
(9) C-109
(10) C-115
(11) C-154
(12) C-149
(13) C-143
(14) T-108 primary (plate)
(15) T-107 primary (plate)
(16) T-106 primary (plate)
(17) T-105 primary (plate)

Figure 6-3. Alignment Points, Tube Side



(1) T-110 secondary (grid)
(2) T-110 primary (plate)
(3) T-104 secondary (grid)
(4) T-104 primary (plate)
(5) T-103 secondary (grid)
(6) T-103 primary (plate)
(7) T-105 secondary (grid)
(8) T-106 secondary (grid)
(9) T-107 secondary (grid)
(10) T-108 secondary (diode plate)

Figure 6-4. Alignment Points, Wiring Side

j. Operate the tenth megacycle Autopositioner to the 1.9 mc position and apply a 21.35 mc signal to the grid of V-102, pin 1, and check the sensitivity.

k. The sensitivity should be essentially the same at 19.45 mc and 21.35 mc. If it is not, balance it as well as possible by using a variable intermediate frequency different from 20.35 mc in steps a. through g. above. If the sensitivity is high at 21.35 mc, move down from 20.35 mc. If the sensitivity is high at 19.45 mc move up from 20.35 mc.

6-7. R-F AMPLIFIER, FIRST MIXER AND HIGH FREQUENCY OSCILLATOR ALIGNMENT.

Only the secondaries of transformers T-101 and T-118 are tuned while both primaries and secondaries of T-102 and T-111 are tuned. L-102 is a single tuned circuit. These circuits are tuned by powdered iron core slugs mounted on a moveable table. The alignment consists of positioning the slugs with respect to the slug table. A trimmer capacitor is connected across each tuned circuit and all except C-140 are accessible for adjustment from the slug rack side of the chassis. C-140 is located adjacent to L-102 within the r-f shield enclosure. See figure 6-4 for location of alignment points.

a. Connect the dc vacuum tube voltmeter (through a one megohm isolating resistor) between pin 7 of crystal oscillator V-112 and ground. (Voltmeter set for measuring negative voltage.)

b. Set trimmer capacitor C-140 to mid capacity. (Screw driver slot parallel to chassis.)

c. Set the receiver frequency to 108.9 mc and adjust the slug in L-102 for maximum dc voltage between the grid of V-112, pin 7, and ground.

d. Set the receiver frequency to 134.9 mc and adjust C-140 for maximum dc voltage between the grid of V-112, pin 7, and ground.

e. Repeat steps c. and d. above until no further increase in dc grid voltage is possible.

f. Check the high frequency oscillator for output at all coarse frequency positions by tuning the receiver in 2 mc steps from 108.9 mc. The dc voltage at the grid of V-112, pin 7, should be between -2.0 and -3.0 volts.

g. Connect dc vacuum tube voltmeter to the grid of first mixer V-102, pin 1. (Voltmeter set for measuring negative voltage.)

h. Set trimmers C-143, C-149, and C-154 to mid capacity. (Approximately 3/8 inch of screw thread visible.)

i. Set receiver frequency to 108.9 mc and adjust slugs in T-118 and T-111 for maximum dc grid voltage on pin 1 of V-102.

j. Set receiver frequency to 134.9 mc and adjust C-143, C-149 and C-154 for maximum dc grid voltage on pin 1 of V-102.

k. Repeat steps i. and j. until no further increase in injection voltage is possible.

l. Check injection voltage at all coarse frequency positions by tuning the receiver in 2 mc steps from 108.9 mc. The dc voltage at the grid of V-102, pin 1, should be more than 0.3 volts.

NOTE

> Injection voltage will vary with the tuning of the secondary of T-102. A conclusive measurement of injection voltage should be made only after the r-f alignment of the receiver is completed.

m. Connect dc vacuum tube voltmeter to the avc line.

n. Connect Boonton 211-A Signal Generator to the antenna connector J-101. Tune to 108.9 mc.

o. Set trimmer capacitors C-101, C-109 and C-115 to mid capacity. (Approximately 3/8 inch of screw thread visible.)

p. Set receiver to 108.9 mc and adjust signal generator output level to produce an avc voltage of 2.0 to 3.0 volts.

q. Adjust the slug in T-101 for maximum avc voltage.

r. Detune the secondary of T-102 by inserting the brass end of the tuning wand into the coil and adjust the iron core slug in the primary for maximum avc voltage.

NOTE

> Adjust signal generator output level as required to maintain a readable avc voltage as a tuning indication when inserting brass slug.

s. Detune the primary of T-102 by inserting the brass end of the tuning wand into the coil and adjust the iron core slug in the secondary for maximum avc voltage.

t. Remove the brass tuning wand from the primary of T-102 and adjust the iron core slug in the secondary of T-111 for maximum avc voltage.

NOTE

> Readjustment of the tuning of T-111 secondary may or may not be necessary. Should the receiver be seriously out of alignment, it is advisable to check the tuning of T-111 secondary with each adjustment of T-102 secondary.

u. Set the receiver and signal generator to 134.9 mc and adjust the signal generator output level to produce an avc voltage of 2.0 to 3.0 volts.

v. Adjust C-101 for maximum avc voltage.

w. Detune the secondary of T-102 by inserting the brass end of the tuning wand into the coil and adjust trimmer capacitor C-109 for maximum avc voltage.

x. Detune the primary of T-102 by inserting the brass end of the tuning wand into the coil and adjust secondary trimmer capacitor C-115 for maximum avc voltage.

y. Remove tuning wand from primary of T-102 and adjust secondary trimmer capacitor C-154 for maximum avc voltage.

z. Repeat steps p. through y. until no further increase in avc voltage is possible.

6-8. TYPICAL PERFORMANCE DATA.

a. R-F SENSITIVITY. - Table 6-1 below presents typical sensitivity data for 51R-3 Navigation Receivers. Measurements are made

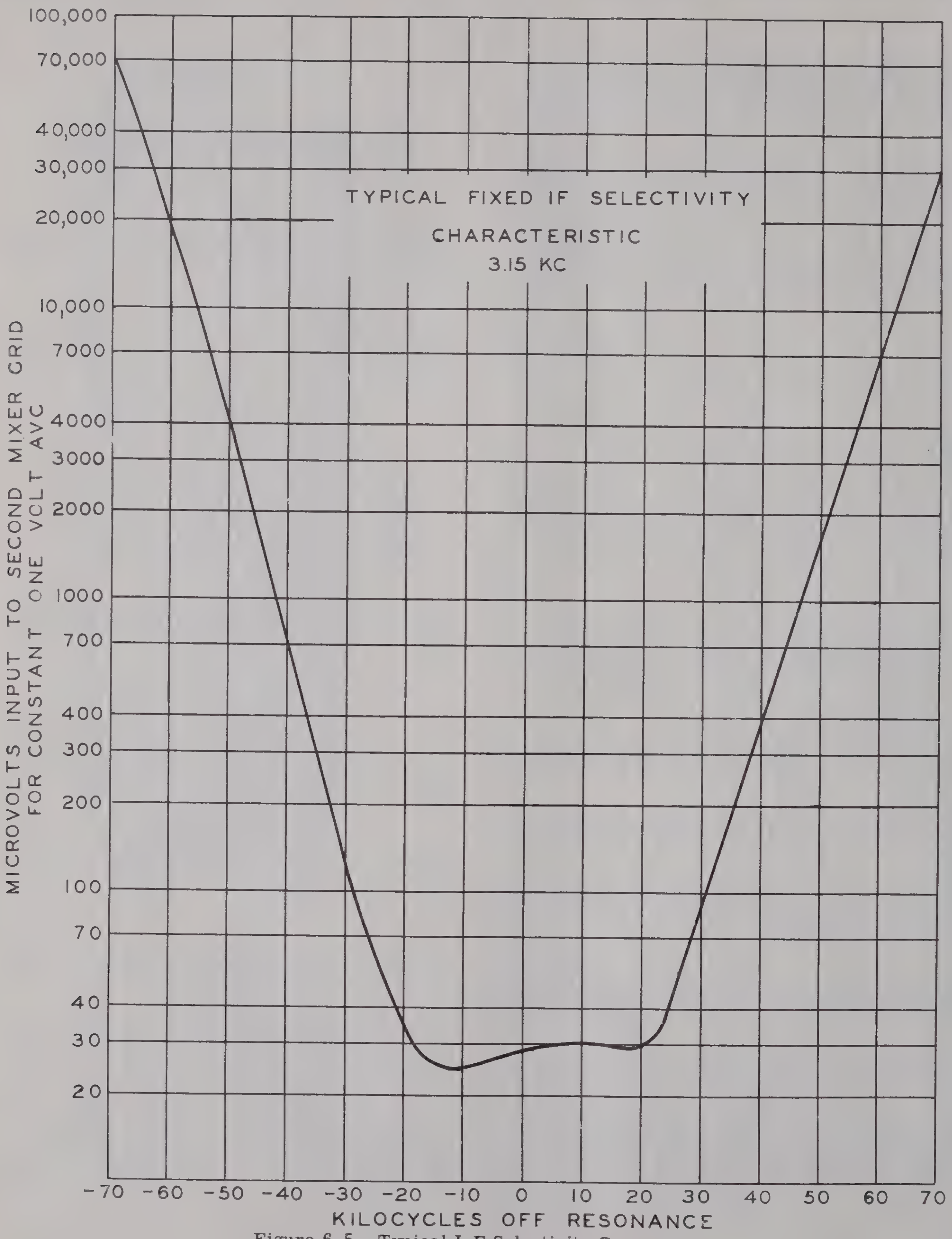


Figure 6-5. Typical I-F Selectivity Curve.

with SQUELCH control, R-150,* adjusted to full clockwise position (minimum squelch action). Sensitivities at the noted locations are based upon signal strengths sufficient to provied 1.0 volt avc. Variations of up to 6 db are not uncommon for individual stage gains. However, antenna sensitivity should not fall below that stated.

b. FIXED I-F SELECTIVITY. - (See figure 6-5.) The typical fixed i-f selectivity characteristic is obtained in the following manner:

(1) Align fixed i-f amplifier. See paragraph 6-8 for procedure.

(2) Connect dc vacuum tube voltmeter (set for measuring negative voltage) to avc line.

(3) Apply 3.15 mc signal to grid of V-104 and record input necessary to obtain 1.0 volt avc.

(4) Shift frequency in 10 kc steps to 80 kc above and 80 kc below 3.15 mc and record input necessary to obtain 1.0 volt avc at each step.

(5) Using information recorded in step (4) above, plot input frequency against microvolts input on semilogarithmic paper and compare resulting curve with that of figure 6-5.

(6) The curve plotted should agree substantially with the one shown in figure 6-5.

c. AVC CHARACTERISTIC. - The avc characteristic is checked in the following manner:

(1) Connect dc vacuum tube voltmeter (set for measuring negative voltage) to avc line.

(2) Using the Boonton signal generator tuned to the frequency indicated on the 314U-Control Unit apply a signal to the antenna input connector, J-101.

(3) Vary input signal from 10 to 50,000 microvolts.

(4) Performance is considered typical when the avc voltage does not exceed 3.5 db total variation as the input is varied from 10 to 50,000 microvolts.

d. AUDIO FREQUENCY RESPONSE. - Audio frequency response is checked in the following manner:

(1) Connect a suitably modulated Boonton Signal Generator to antenna input connector J-101 and tune receiver and signal generator to 114.9 mc.

(2) Connect an output meter or vacuum tube voltmeter to audio output transformer or output terminals.

(3) Vary frequency of modulating signal from 30 to 10,000 cps.

(4) Performance is considered typical when response is flat within 6 db from 300 to 3500 cps. Frequencies of 90, 150 and 10,000 cps should be at least 20 db down.

e. VOR PHASE ANGLES. - Phase angles in the receiver may be measured by following the procedure outlined below:

(1) Use the following test conditions:

R-F input: 1000 microvolts at 114.9 mc.
Modulation: VOR - 30% 9960 cps FM plus 30% 30 cps or as specified under individual test.
DC input: 26.5 volts.
AC input: 26. volts 400 cps when required.
RF source: Boonton Signal Generator 211-A.
Modulator: Collins 479S-3 Signal Generator.
Oscilloscope: (See paragraph 6-2.)
MAGNETIC BEARING on 336A-2 Omni-Bearing Selector set to 000 degrees.
PHASE ANGLE SELECTOR on 479S-3 Signal Generator set to 000 degrees.

(2) To observe phase angles in that portion of the circuit associated with and following manual resolver amplifier V-115B connect the test point in question to the vertical input of the oscilloscope and the 30 cps variable phase from the 479S-3 Signal Generator to the horizontal input of the oscilloscope. Avoid use of auxiliary filters to insure that no unequal loading is incurred. This is absolutely necessary since the vertical input is used as a probe to observe the phase of voltages across various impedance levels. Modulation used for this test is 30% 9960 FM only. After the OBI has been set to 000 degrees, remove the 26 volt 400 cps power to prevent further rotation. Phase angles are obtained by rotating the PHASE ANGLE SELECTOR on the 479S-3 Signal Generator until an in phase pattern is observed on the oscilloscope.

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* A collar secured to the shaft of the Squelch Control, R-150, limits the maximum squelch setting to any desirable value up to the maximum threshold. If more range is desired than that provided by the factory adjustment of the collar, it is necessary to loosen the collar set screw, adjust the Squelch Control to the maximum threshold desired, and tighten the set screw.

Table 6-1.

Signal Input to	Pin Number	Function	Frequency (megacycles)	Sensitivity (microvolts)
Antenna	J-101		108-136	3.
V-101	1	RF Amplifier	108-136	5.
V-102	1	1st Mixer	19.45 - 21.35	10.
V-103	1	Var. Freq. I-F	19.45 - 21.35	40.
V-104	1	2nd Mixer, g.	19.45 - 21.35	200.
V-104	5	2nd Mixer, g.	3.15	40.
V-105	1	1st Fixed I-F	3.15	500.
V-106	1	2nd Fixed I-F	3.15	10,000.
V-107	1	3rd Fixed I-F	3.15	200,000.

Table 6-2.

Test Point	Phase Angle (Degrees)	Accuracy of Reading
V-115.2	7	±2 degrees
V-115.3	6	±2 degrees
V-119.1	251	±3 degrees
V-119.6	70	±3 degrees
T-113.8	67	±3 degrees
T-113.6	69	±3 degrees
T-114.1	69	±3 degrees
T-114.3	249	±3 degrees
T-114.5*	242	±3 degrees

* Ground T-114.6 for this measurement only.

Table 6-3.

Test Point	Phase Angle (Degrees)	Accuracy of Measurement
V-118.2	187	±2 degrees
V-118.3	186	±2 degrees
V-123.1	72	±3 degrees
V-123.6	251	±3 degrees
T-116.8	249	±3 degrees
T-116.6	251	±3 degrees
V-124.1	251	±3 degrees
V-124.6	72	±3 degrees
V-125.2	237	±3 degrees
V-125.7	57	±3 degrees

NOTE

> This pattern is generally a diagonal line sloping upward to the right. It can be determined for any oscilloscope by connecting the same signal to both horizontal and vertical inputs. Under some conditions a straight line may be difficult to produce due to presence of 2nd harmonics. A figure eight pattern may be used by properly centering the cross of the pattern.

The estimated accuracy of observation is associated with each recorded phase angle in Table 6-2. (Signal frequency 30 cps.)

(3) To observe phase angles in that portion of the circuit associated with and following automatic resolver amplifier V-118A carry out procedure as in step (2) above. Proper phase angles are listed in Table 6-3. (Signal frequency 30 cps.)

(4) To observe phase angles in that portion of the circuit designated variable phase channel carry out procedures as outlined in step (2) above with the following two exceptions.

(5) Connect horizontal input of the oscilloscope to the 30 ∿ REF ϕ output connector on the 479 S-3 Signal Generator.

(6) Change SPECIFIC SIGNAL SELECTOR on the 479S-3 Signal Generator to the 30 ∿ VAR ϕ position.

(7) Table 6-4.

Test Point	Phase Angle (Degrees)	Accuracy of Measurement
R-142 arm	177	±2 degrees
R-195-196	180	±2 degrees
C-187.6	154	±3 degrees
Z-103.1	173	±3 degrees
Z-103.5	18	±3 degrees
V-121.1	195	±4 degrees
V-121.6	17	±4 degrees
V-122.2	20	±4 degrees
V-122.7	198	±4 degrees
T-115.3	201	±4 degrees
T-115.1	20	±4 degrees
T-115.5*	208	±4 degrees
V-126.8	197	±4 degrees
V-124.1**	197	±4 degrees
V-124.6**	197	±4 degrees
V-125.2**	211	±5 degrees
V-125.7**	211	±5 degrees

* Ground T-115.6 for this measurement only.

** Ground Z-104.8 for this measurement only to eliminate noise interference.

6-9. INSTRUMENTATION SECTION ALIGNMENT.

a. PRELIMINARY PROCEDURES.

(1) If the test equipment has not been calibrated proceed with calibration as detailed in paragraph 6-3. The test equipment should be calibrated each time it is used and the modulation levels checked frequently during alignment.

(2) Turn on all test equipment and allow ten minutes for warm-up before proceeding with the alignment.

(3) Check the voltage of the power source. Maintain this voltage at 26.5 volts dc ±0.5 volt throughout the alignment procedures unless otherwise specified.

(4) Tune the Boonton 211-A Signal Generator to 114.9 mc by turning OSC SEL switch to XTAL position and XTAL switch to 114.9 MC position. Adjust to 1000 microvolts output with RF LEVEL control.

(5) Set the 314U-Control Unit to 114.9 mc.

(6) Turn FUNCTION SELECTOR switch on the 479S-3 Signal Generator to SPECIFIC SIG and turn SPECIFIC SIGNAL SELECTOR switch to the 30 ∿ VAR ϕ position.

(7) Adjust MASTER ATTENUATOR for 30% modulation of the Boonton signal generator as read on the lower scale of the Boonton signal generator PERCENT MODULATION meter.

(8) With the ac vacuum tube voltmeter connected from TP-102, to ground, adjust the DETECTOR LEVEL control, R-142, to give 34 volts. This setting of R-142 should give a reading of approximately 1.4 volts from the arm of R-142 to ground.

(9) Turn SPECIFIC SIGNAL SELECTOR switch to 9960 FM position.

(10) Adjust MASTER ATTENUATOR for 30% modulation of the Boonton signal generator as read on the PER CENT MODULATION meter.

(11) With the AC vacuum tube voltmeter connected from TP-101 to ground adjust the REF PHASE LEVEL, R-181, to give 34 volts.

b. VOR ZERO ADJUSTMENT.

(1) Complete procedures under paragraph 6-9a above.

(2) Set the AUTO SENS control (R-223), AUTO CENTER control (R-225), and TRACKING CONTROLS, MANUAL (R-180) and AUTOMATIC (R-207) in the approximate middle of their respective ranges. Set DEV IND LOCALIZER SENS control (R-194) to its full counterclockwise position.

(3) Tune the Boonton signal generator to 114.9 mc by turning OSC SEL switch to XTAL position and XTAL switch to 114.9 MC position. Adjust to 1000 microvolts output with RF LEVEL control.

(4) Turn the FUNCTION SELECTOR switch on the 479S-3 Signal Generator to ODR and the PHASE ANGLE SELECTOR to 100.0 degrees.

(5) Set the 314U-Control Unit to 114.9 mc.

(6) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver a 30% 30 cps variable phase and a 30% 9960 cps signal. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(7) Turn the knob on the 336A-2 Omni-Bearing Selector (hereafter referred to as OBS) for a MAGNETIC BEARING indication of 100 degrees. The TO-FROM indication will be FROM.

(8) With the dc vacuum tube voltmeter connected from TP-103 to ground adjust AUTO SENS control R-223 to give 40 volts.

(9) Adjust VOR ZERO (R-198) control for exact zeroing of the vertical needle of the deviation indicator.

(10) Adjust AUTO CENTER (R-225) control for a reading of 280. degrees on the 337A-2 Omni-Bearing Indicator.

(11) Turn the knob on the OBS to indicate a MAGNETIC BEARING of 280 degrees. The TO-FROM indication will be TO.

(12) The vertical needle on the deviation indicator will probably be slightly off center. Adjust the PHASE CENTERING (R-240) control to reduce this reciprocal error by one-half.

(13) Turn the knob on the OBS to indicate a MAGNETIC BEARING of 100 degrees. The TO-FROM indication will be FROM.

(14) Adjust the VOR ZERO (R-198) control for exact centering of the vertical needle and the AUTO CENTER (R-225) control for a reading of 100 degrees on the RMI.

(15) Turn the FUNCTION SELECTOR switch on to the CAL position and the SPECIFIC SIGNALS SELECTOR to the 9960 FM position. The deviation indicator should be within 5 microamperes of zero.

c. VOR DEVIATION INDICATOR SENSITIVITY ADJUSTMENT.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and the 30% 9960 cps signal at 114.9 mc, crystal frequency (XTAL switch to 114.9 MC). Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set the frequency on the 314U-Control Unit to 114.9 mc.

(4) Turn the FUNCTION SELECTOR switch on the 479S-3 Signal Generator to the ODR position and the PHASE ANGLE SELECTOR to a course setting 10 degrees from MAGNETIC BEARING reading on the OBS.

(5) Adjust VOR SENS (R-243) control for a 150 microampere deflection on the deviation indicator.

d. PROCEDURES FOR VOR AUTOMATIC (OBI) SENSITIVITY ADJUSTMENT.

(1) Repeat steps (1), (2), and (3), of paragraph 6-9c above.

(2) Turn the FUNCTION SELECTOR to ODR position.

(3) Adjust AUTO SENS control, R-223, until a dc voltage indication of 40 volts is obtained at TP-103 to ground.

e. TRACKING CONTROL ADJUSTMENTS.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc, crystal frequency. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Turn the FUNCTION SELECTOR switch on the 479S-3 Signal Generator to the ODR position and the PHASE ANGLE SELECTOR to 160 degrees.

(5) Turn the knob on the OBS to a MAGNETIC BEARING of 160 degrees. The TO-FROM indication will be FROM.

(6) Adjust MANUAL (R-180) tracking control for exact zeroing of the vertical needle of the deviation indicator.

(7) Adjust AUTOMATIC (R-207) tracking control for a reading of 340. degrees on the 337A-2 Omni-Bearing Indicator.

(8) Turn the PHASE ANGLE SELECTOR and the OBS controls to 100.0 degrees and recheck the VOR zero adjustment by repeating steps (7) through (14) of paragraph 6-9b.

(9) Repeat steps (4) through (8) for maximum accuracy.

f. LOCALIZER ADJUSTMENT.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator to deliver 1000 microvolts at 110.1 mc, crystal frequency and to deliver 90 and 150 cycle tones, 20% modulated. Refer to paragraph 6-5 for method of adjusting amount of modulation.

(3) Set the 314U-Control Unit to 110.1 mc.

(4) Set the FUNCTION SELECTOR of the 479S-3 Signal Generator to the TONE LOC position and the TONE LOCALIZER db ratio control to 0.

(5) Adjust LOC CENTERING CONTROL, R-236, for exact centering of the deviation indicator.

(6) Set the TONE LOCALIZER db ratio control to the left 4 db position.

(7) Adjust TONE LOC DEV IND SEN (R-194) control for a 90 microampere deflection to the left on the deviation indicator.

(8) Set the TONE LOCALIZER db ratio control to the right 4 db position and check to see that the deflection of the deviation indicator is 90 microamperes to the right. Acceptable adjustment is 90 ±5 microamperes. Full scale deflection of deviation indicator is 150 microamperes.

g. RECIPROCAL ERROR CHECK.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Turn the knob on the OBS to a MAGNETIC BEARING of 000 degrees and the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator to 000 degrees. The TO-FROM indication will be FROM.

(5) Adjust the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator slightly to obtain exact zeroing of the vertical needle on the deviation indicator. Record the setting of the PHASE ANGLE SELECTOR control.

(6) Turn the knob on the OBS to a MAGNETIC BEARING of 180 degrees and again center the vertical needle on the deviation indicator by means of the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator keeping the control near 000. Record the setting of the PHASE ANGLE SELECTOR control.

(7) Turn the PHASE ANGLE SELECTOR control to 180 degrees and the OBS control to 180 degrees.

(8) Adjust the PHASE ANGLE SELECTOR control for exact zeroing of the deviation indicator. Record the reading of the PHASE ANGLE SELECTOR.

(9) Turn the OBS control to 000 degrees and the PHASE ANGLE SELECTOR control for exact zeroing of the deviation indicator at approximately 180 degrees. Record the setting of the PHASE ANGLE SELECTOR control.

(10) The difference in the readings between steps (5) and (6) and between (8) and (9) should be less than 0.5 degrees.

h. VOR FLAG ADJUSTMENT.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton Signal Generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc, crystal frequency. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set 314U-Control Unit to 114.9 mc.

(4) Turn FUNCTION SELECTOR switch on the 479S-3 to ODR position and the PHASE ANGLE SELECTOR to 0 degrees.

(5) Turn knob on OBS to a MAGNETIC BEARING of 0 degrees.

(6) Adjust FLAG ADJUST Control R-237 for a total flag current of 0.4 ma with an r-f input of 1000 uv, modulated 30% with either variable phase or reference phase signal.

i. TO-FROM INDICATOR TEST.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Turn the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator to 000 degrees.

(5) Turn the OBS control for exact zeroing of the deviation indicator.

(6) Turn the PHASE ANGLE SELECTOR control 180 degrees and read the TO-FROM indication.

(7) Turn the PHASE ANGLE SELECTOR control back to 000 degrees and again read the TO-FROM indication.

(8) The readings on the TO-FROM indicator should be greater than 250 microamperes on either side of the zero point for both the TO and FROM positions.

j. VOR ERROR CURVE.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Turn the 314U-Control Unit to 114.9 mc.

(4) Turn the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator to 000 degrees.

(5) Turn the OBS control until exact zeroing of the deviation indicator is obtained with the TO-FROM indicator indicating FROM. Record the reading in the MAGNETIC BEARING window of the OBS and the reading of the OBI.

(6) Repeat steps (4) and (5) above for every 30 degrees around the 360 degree scale recording the readings of the two instruments as in (5) above for each setting.

(7) The difference between the highest positive error and the lowest negative error should not be over two degrees for OBS and three degrees for the OBI.

k. FLAG ALARM SENSITIVITY TEST.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Turn the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator to 000 degrees.

(5) Turn OBS control for exact zeroing of the deviation indicator.

(6) Change the r-f output of the Boonton signal generator from 1000. microvolts to 5.0 microvolts.

(7) Each of the two flag movements should indicate between 0.25 and 0.35 ma (0.5 to 0.7 ma total flag current) at 1000 uv and not less than 0.25 ma (0.5 total flag current) at 5 uv.

l. VOR STABILITY TESTS UNDER VARYING CONDITIONS. VARIATION OF R-F SIGNAL LEVEL.

(1) Complete procedure under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc (crystal control). Refer to paragraph 6-4 for method of checking the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Set the RF LEVEL control of the Boonton signal generator to 1000. microvolts.

(5) Turn the OBS control to a MAGNETIC BEARING of 000 degrees and a TO-FROM indication of FROM.

(6) Adjust the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator for exact zeroing of the deviation indicator. Do not change the PHASE ANGLE SELECTOR control setting for the remainder of the procedure.

(7) Record the MAGNETIC BEARING indication (000.0) on the OBS and the reading of the OBI.

(8) Decrease the output level of the Boonton signal generator to 10.0 microvolts.

(9) Turn the OBS control for exact centering of the deviation indicator and record the MAGNETIC BEARING indication and the reading of the OBI.

(10) Increase the output level of the Boonton signal generator to 50,000 microvolts.

(11) Adjust the OBS control for exact zeroing of the deviation indicator and record the MAGNETIC BEARING indication and the reading of the OBI.

(12) The MAGNETIC BEARING indications on the OBS should not vary more than one degree and the readings of the OBI should not vary more than two degrees when the input signal level is varied from 10 to 50,000 microvolts.

m. VARIATION OF MODULATION LEVEL.

(1) Complete procedure under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and 30% 9960 cps signal at 114.9 mc. Refer to paragraph 6-4 for method of checking the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Set the RF LEVEL control of the Boonton signal generator to 1000 microvolts.

(5) Turn the OBS control to a MAGNETIC BEARING of 000 degrees and a TO-FROM indication of FROM.

(6) Adjust the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator for exact zeroing of the deviation indicator. Do not change the PHASE ANGLE SELECTOR control setting for the remainder of the procedure.

(7) Record the MAGNETIC BEARING indication (000.0) of the OBS and the reading of the OBI.

(8) Increase the modulation percentage by 25%, that is, to 37.5%.

(9) Turn the OBS control for exact zeroing of the deviation indicator. Record the indication and the reading of the OBI.

(10) Decrease the modulation percentage by 25%, that is, to 22.5%.

(11) Turn the OBS control for exact zeroing of the deviation indicator. Record the indication and the reading of the OBI.

(12) The MAGNETIC BEARING indications of the OBS should not vary more than ±0.5 degree and the readings of the OBI should not vary more than ±1.0 degree as the modulation level is varied 25% from its normal setting.

n. VARIATION OF LINE VOLTAGE.

(1) Complete procedures under paragraph 6-9a above.

(2) Set up the Boonton signal generator and the 479S-3 Signal Generator to deliver 30% 30 cps variable phase signal and a 30% 9960 cps signal at 114.9 mc. Refer to paragraph 6-4 for method of adjusting the amount of modulation.

(3) Set the 314U-Control Unit to 114.9 mc.

(4) Set the RF LEVEL control of the Boonton signal generator to 1000. microvolts.

(5) Determine that the d-c input voltage to the receiver is 26.5 volts.

(6) Turn the OBS control to 000 degrees with a TO-FROM indication of FROM.

(7) Adjust the PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator for exact zeroing of the deviation indicator. Do not change the PHASE ANGLE SELECTOR control setting for the remainder of the procedure.

(8) Record the MAGNETIC BEARING indication (000.0) and the reading of the OBI.

(9) Lower the d-c supply voltage 10% to 23.9 volts. Wait one minute.

(10) Turn the OBS control for exact zeroing of the deviation indicator. Record the MAGNETIC BEARING indication and the reading of the OBI.

(11) Raise the d-c supply voltage 10% to 29.1 volts. Wait one minute.

(12) Turn the OBS control for exact zeroing of the deviation indicator. Record the MAGNETIC BEARING indication and the reading of the OBI.

(13) Return the d-c power supply voltage to 26.5 volts.

(14) The MAGNETIC BEARING indications should not vary more than ±0.5 degree and the readings of the OBI should not vary more than ±1.0 degree as the d-c supply voltage is varied ±10% from 26.5 volts.

6-10. TESTING OF AND GENERAL INFORMATION ON AUDIO TRANSFORMERS AND FILTERS.

a. OUTPUT TRANSFORMER T-109. - T-109 is of conventional design and construction. If it is suspected of causing intolerable distortion determine whether the distortion is due to T-109 or to the noise limiter before replacing T-109. The clipping type of noise limiter can cause distortion since it is designed to clip the top of all signals, desired or undesired, at percentage modulations above approximately 30%.

b. TRANSFORMER T-112. - T-112 contains a tuned inductance utilized in the FM-AM translator circuit as well as a linear step-up transformer. The former contributes to the amount of AM generated as a function of the deviation ratio on the 9960 cps FM subcarrier. Any change in the resonant frequency or Q of the inductor associated with T-112 will result in a change in omni-range deflection sensitivity. Changes in the linearity (frequency response) of the step-up portion of T-112 in the region of 9 to 11 kilocycles will result in imposing additional AM on the combined AM-FM signal presented to bridge rectifier CR-101. This, in turn, will add to or subtract from the desired AM, causing a small change in deflection sensitivity. This is a rare occurrence.

c. TRANSFORMERS T-113 AND T-116. -Transformers T-113 and T-116 are identical in both construction and application. Both are tuned during construction to a frequency of 30 cps ±1/2 % with an internal capacitor of approximately .01 mfds. (See figure 12-1.) This capacitor is connected across the two secondary windings in series by jumpering terminals 3 and 7. A third winding (1-2) is included to provide a low impedance test point which can be used as an observation point without disturbing phase relations in the associated circuits.

Refer to Table 6-5 if shorted turns are suspected. Note that an accurate measure of winding resistance can be had without removing any circuit connections.

An indication as to proper tuning of either T - 113 or T-116 must be obtained by application of phase measuring techniques. The conventional resonance curve method is not sufficiently accurate. This information is readily obtainable by observation of the phase of the voltage drop across R-

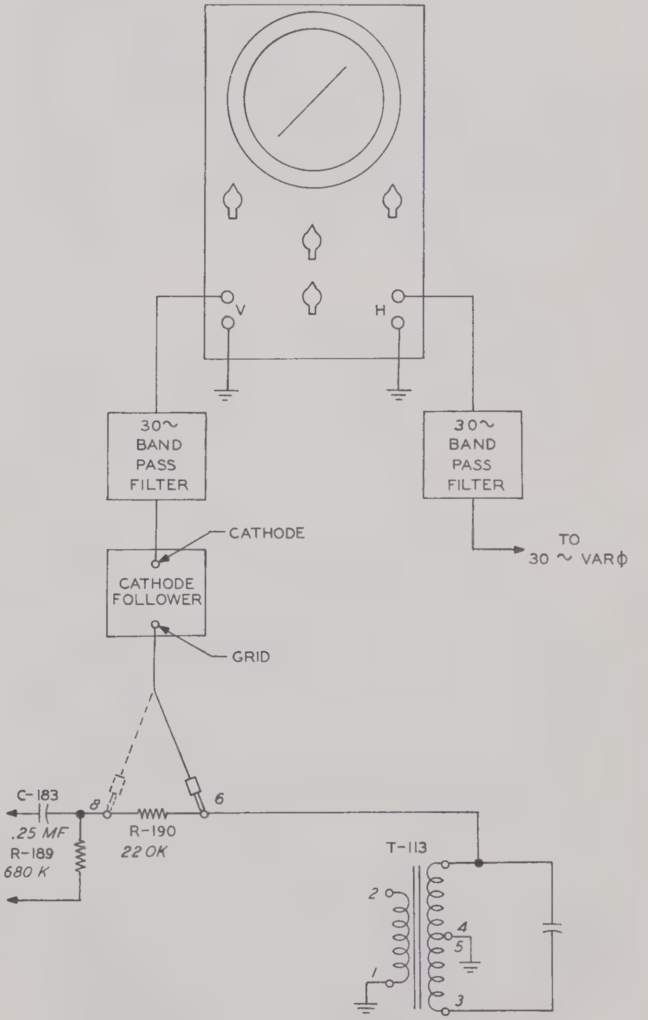


Figure 6-6. Connections for Testing T-113,T-116

190 in the case of T-113 and R-215 in the case of T-116. If the transformer is at exact resonance (unity power factor) then no reactive current will flow through the resistor and no phase angle difference will exist across it.

CAUTION

Transformers T-113 or T-116 are seldom the cause of equipment malperformance. Be certain of measurements before replacing these components.

To test T-113 and T-116 for proper tuning make connections shown in figure 6-6. It will be helpful to adjust the 336A-2 Omni-Bearing Selector to approximately 300 degrees. This will couple the resolver rotor in the 336A-2 Omni-Bearing Selector to that stator which sees the maximum attenuation to harmonics through Z-104. This in turn provides a better oscilloscope pattern and improves the accuracy of measurement. Band pass filters must be used to obtain a good oscilloscope pattern and to further improve the accuracy of measurement. A cathode follower is used in series with the test probe to decrease the loading effect of the oscilloscope input at the transformer.

Test Conditions:

Input to 51R-3 Receiver:

D.C. - 26.5 v.
R-F - 114.9 mc 1000 uv modulation 30% 9960 FM only.
AC - 26 v. 400 cps

Procedure:

(1) Using a short length, low capacity (50 mmf or less) lead from the cathode follower grid to the test probe, observe phase angle of voltage at T-113, terminal 8. Adjust PHASE ANGLE SELECTOR control on the 479S-3 Signal Generator for an in phase pattern on oscilloscope. (See Figure 6-6).

2) Move test lead from T-113, terminal 8, to T-113, terminal 6. Readjust PHASE ANGLE SELECTOR control for an in-phase pattern on oscilliscope.

(3) The phase difference across R-190 will be the difference between readings in steps (1) and (2) above.

NOTE

It will be necessary to adjust the oscilloscope gain to the point where only the center portion of the trace is visible, the remainder being off scale. Further, the vertical and horizontal gains should be adjusted so as to provide a pattern approximately 45 degrees from vertical. An indication as to sensitivity of observation can be had by temporarily clipping a 100 uuf capacitor between terminals 3 and 6 of T-113. This will cause a phase angle change of approximately one degree in a properly operating receiver.

Phase shifts across R-190 or R-215 up to two or three degrees will not impair normal operation of the receiver providing the proper VOR zero can be reached by means of adjustments on C-187, R-157 and the VOR ZERO control (R-198). Phase shifts in excess of three degrees will tend to introduce course drift as a function of temperature inasmuch as R-190 (or R-215) will be looking into a load (T-113 or T-116) which is not purely resistive. Thus any change in either R-190 (or R-215) or the load will result in a phase angle change. Initial adjustment of T-113 and T-116 is such that not greater than approximately ± one degree should be observed across R-190 and R-215.

d. TRANSFORMERS T-114 AND T-115. - T-114 and T-115 are identical in both construction and application. Both are tuned to resonance at 30 cps ±1-1/2% with internal capacitance totaling approximately 0.27 mfd. (See figure 12-1). This capacitance is connected across the primary of the transformer by externally jumpering terminals 3 and 4.

T-114 and T-115 are adjusted to provide a unity power factor circuit comprised of the tuning capacitor, primary self inductance and secondary inductance referred to the primary side. By so doing, vacuum tubes V-120 and V-122 see a resistive load. This permits variation in tube dynamic plate resistance without incurring attendant variations in phase angle. In fact, a ready check on the proper tuning of T-114 or T-115 is to insert various 5814 tubes in sockets XV-120 and XV-122 respectively. Properly tuned circuits will result in observed phase angle changes in the order of ±1/2 degree or less.

NOTE

> It is important to note that reference is made to the primary side in resonating transformers T-114 and T-115. It will be observed that the fixed phase shift from T-114 terminal 1 to terminal 5, for example, is in the order of 187 to 188 degrees This in itself is not significant other than to highlight a source of possible confusion. Always check the resonant condition of T-114 and T-115 in the primary side.

To check T-114 for proper tuning observe the phase relation of the voltage at the grid of V-120, pin 7, with respect to that at the plate, pin 6. This can best be done by reference to figure 6-7. A properly tuned T-115 will indicate 180. ±2 degrees between grid and plate of V-120. It should be observed that departures of up to ±4.0 degrees will not seriously affect performance unless such departures preclude proper zeroing of the receiver by means of C-187, R-157, and the VOR ZERO control (R-198). It is necessary to use a 10 megohm grid resistor in the cathode follower (See figure 6-7). The cathode follower is necessary to decrease the loading effect of the oscilloscope input at the grid of V-120. Band pass filters are necessary to improve the oscilloscope pattern, which results in greater accuracy of measurements. The size of the blocking capacitor should be approximately 0.25 mfd.

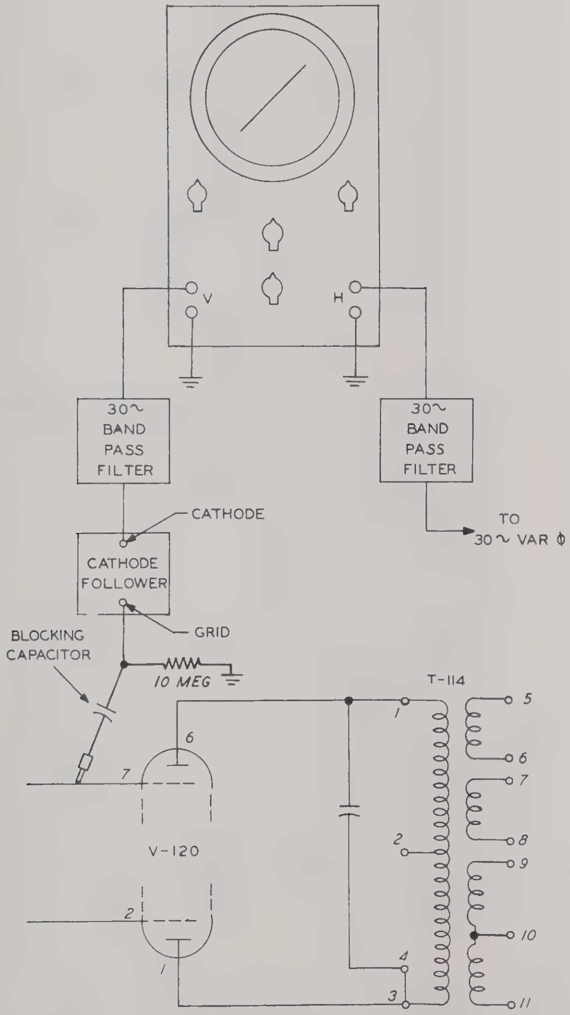


Figure 6-7. Connections for Testing T-114.

Test Conditions:

Input to 51R-3 Receiver.

D.C. - 26.5 v.
R-F - 114.9 mc 1000 uv modulation 30%
9960 FM only
AC - 26 v. 400 cps
336A-2 Omni-Bearing Selector - 300 degrees.

Procedure:

(1) Using a short length of low capacity (50 uuf or less) lead from the cathode follower grid to the test probe, a series blocking capacitor, and a 10 megohm cathode follower grid resistor, observe phase of voltage at grid, pin 7, of V-120. Adjust PHASE ANGLE SELECTOR of the 479S-3 Signal Generator for in-phase pattern on oscilloscope.

(2) Move test lead from pin 7 to pin 6 of V-120. Adjust vertical gain of oscilloscope to permit approximately same vertical deflection noted in step (1) above. Readjust PHASE ANGLE SELECTOR of the 479S-3 Signal Generator for an in-phase pattern on oscilloscope.

(3) Phase difference between grid and plate will be difference in readings of PHASE ANGLE SELECTOR in steps (1) and (2) above.

NOTE

> It will be necessary to adjust the oscilloscope gain to the point where only the center portion of the trace is visible, the remainder being off scale. Further, the vertical and horizontal gains should be adjusted so as to provide a pattern approximately 45 degrees from vertical. To insure accurate results from this test it is essential that the oscilloscope employed be in good working order. Note that in going from terminal 7 to 6 of V-120, a voltage rise of approximately 14 times is incurred. Thus the oscilloscope vertical input circuit must be such that phase shift

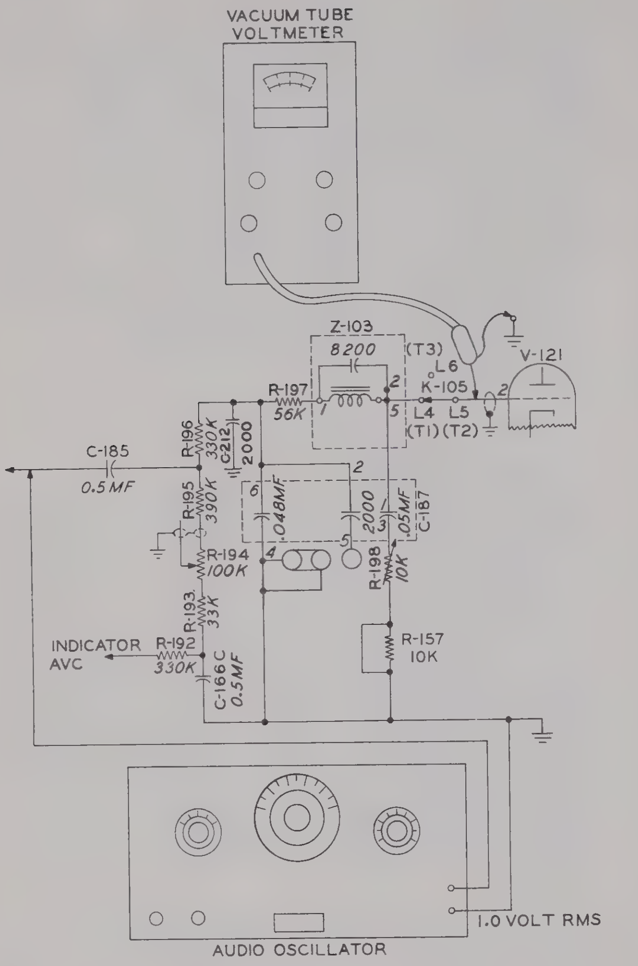


Figure 6-8. Connections for Testing Z-103,C-187

will not be incurred as a function of gain control setting. An oscilloscope equal to or better than that specified in paragraph 6-2 will normally meet this requirement.

To check T-115 for proper tuning observe the phase angle relation of the voltage at the grid of V-122, pin 7 with respect to that at the plate, pin 6. Comments applicable to the tuning of T-114 apply to T-115 except that the horizontal input to the oscilloscope should be connected to the reference phase signal instead of the variable phase signal as shown in figure 6-7. In addition it should be noted that the excitation of grids 2 and 7 of V-122 cannot be in exact phase opposition because of the phase inverter action and the phase shift through coupling capacitors C-188 and C-189. Accordingly identical results should not be expected when observing the phase relations of the grids relative to their respective plates.

Test Conditions:

Input to 51R-3 Receiver:

D.C. - 26.5 v.
R-F - 114.9 mc 1000 uv modulation 30% at 30 cps variable phase only.

Procedure:

(1) Using a short length, low capacity (50 uuf or less) lead from the cathode follower grid to the test probe, a series blocking capacitor, and a 10 megohm cathode follower grid resistor, observe phase of voltage at grid, pin 7, of V-122. Adjust PHASE ANGLE SELECTOR of the 479S-3 Signal Generator for in-phase pattern on oscilloscope.

(2) Move test lead from pin 7 to pin 6 of V-122. Readjust PHASE ANGLE SELECTOR of the 479S-3 Signal Generator for in-phase pattern on oscilloscope.

(3) Phase difference between grid and plate will be difference in readings of PHASE ANGLE SELECTOR in steps (1) and (2) above.

NOTE

It will be necessary to adjust the oscilloscope gain to the point where only the center portion of the trace is visible, the remainder being off scale. Further, the vertical and horizontal gains should be adjusted so as to provide a pattern approximately 45 degrees from vertical. To insure accurate results from this test it is essential that the oscilloscope employed be in good working order. Note that in going from terminal 7 to 6 of V-122, a voltage rise of approximately 14 times is incurred. Thus the oscilloscope vertical input circuit must be such that phase shift will not be incurred as a function of gain control setting. An oscilloscope equal to or better than that specified in paragraph 6-2 will normally meet this requirement.

e. TRANSFORMER T-117. - Transformer T-117 is comprised of two saturable reactors having separate windings and separate magnetic circuits.

Its function is to use the dc plate currents of V-125 to control a two phase motor in the 337A-2 Omni-Bearing Indicator. This is done by causing the dc primary current to saturate the core and thus greatly lower the impedance of the secondary windings which are in series with the stators of the two phase motor. Negligible coupling exists between the primary and associated secondary winding. Normally, approximately one milliampere flows through each primary winding. A wide variation from this value could be indicative of shorted turns. An open primary will result, obviously, in interrupted plate current of the associated section of V-125.

f. **FILTER Z-101.** -Filter Z-101 is a high pass design having a 150 cps response at least 20 db below its 1000 cps response. Testing of this component can be accomplished most readily by means of normal frequency response techniques. Refer to typical performance, paragraph 6-8d (4) for low frequency attenuation figures. Filter Z-101 does not appreciably alter the high frequency (above 400 cps) response.

CAUTION

In checking Z-101 for tuning capacitor leakage do not use d-c voltages greater than 300 v dc.

g. **FILTERS Z-102 and Z-104.** - Filter Z-102 is nominally a 10, 160 cps antiresonant circuit. Circuit capacities reduce the resonant frequency to a figure of approximately 9960 cps. D.C. resistance values are given in Table 6-1. Maintenance of Z-104 is covered in Section 9.

h. **FILTER Z-103.** - Filter Z-103 constitutes a parallel resonant circuit tuned to 60 cps by means of an internally mounted capacitor. This capacitor is connected across its associated in-

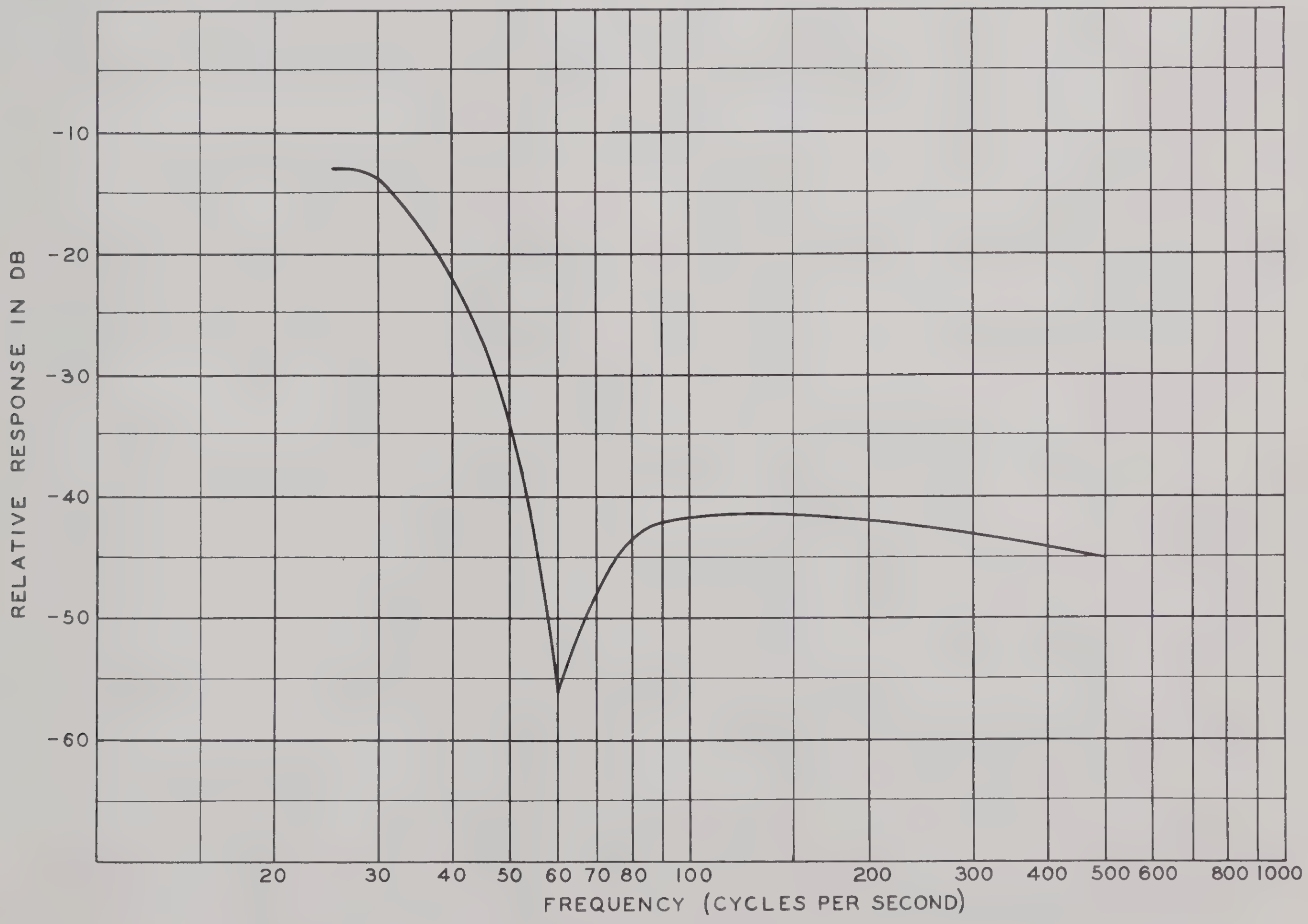


Figure 6-9. Z-103 Frequency Response Characteristic.

ductance by externally jumpering terminals 2 and 5. Z-103 is part of a modified m-derived filter configuration which includes capacitor assembly C-187. (See figure 12-1.) A shorting bar on C-187 provides an increment of phase shift useful in zeroing the receiver. The VOR ZERO control (R-198) serves a similar purpose except that continuous adjustment is possible. Resistor R-157 provides an increment of phase shift opposite that of C-187 shorting bar. Note that the phase shift through the Z-103-C-187 filter configuration will vary from one receiver to the other as a function of the settings of R-198 and C-187. The order of variation can be as much as 6 to 8 degrees although 3 to 4 degrees is a typical figure. Thus phase shift measurement will serve to locate gross failures but not small variations.

In the servicing and testing of the Z-103-C-187 filter configuration three important facts must be kept in mind. First, Z-103 determines the frequency (nominally 60 cps) of the point of maximum attenuation observed in the frequency response characteristic. Secondly, the position of the VOR ZERO control (R-198) has a negligible effect on the frequency response characteristic. Thirdly, the position of the shorting bar on C-187 and R-157 being in or out of the circuit has a negligible effect on the frequency response characteristic. To obtain data for plotting a frequency response characteristic similar to that of figure 6-9 use connections shown in figure 6-8 and follow procedure below:

Test Conditions:

Apply no power to receiver.

Procedure:

(1) Connect the audio oscillator output to capacitor C-185 (forward terminal).

(2) Adjust output to 1.0 volts rms. This must be held constant as the audio frequency is varied.

(3) Connect an ac vacuum tube voltmeter to V-121, pin 2. Use a well shielded lead having a capacitance not greater than 300 uuf.

(4) Vary frequency and record output read on vacuum tube voltmeter.

i. FILTERS Z-105 AND Z-106. - Filters Z-105 and Z-106 are identical in function with the exception that Z-105 provides a passband centered around 90 cps and Z-106 a passband centered around 150 cps. Variation in transmission characteristics will result in variation in tone localizer deflection sensitivity and/or centering. In general, faulty Z-105 or Z-106 filters will be evidenced by the pilot's inability to bracket the localizer course or the maintenance technician's inability to center the vertical needle on the deviation indicator when following the alignment procedures of paragraph 6-9f.

CAUTION

Do not use voltages above 500 volts dc in testing Z-105 and Z-106. These filters are tuned with 500 v dc working voltage capacitors. Test voltages exceeding this value can result in damage to the filters.

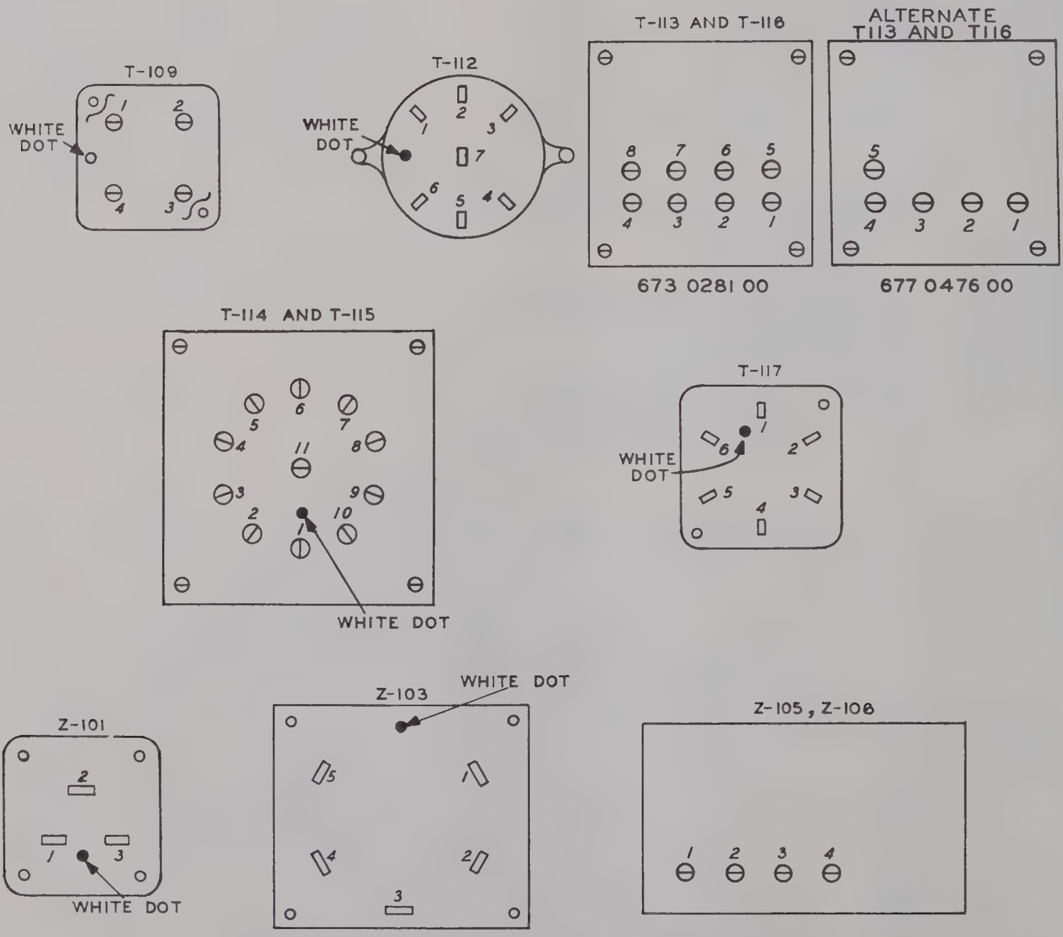
TABLE 6-5

TABLE OF TRANSFORMER WINDING RESISTANCES

Symbol No.	Function	Terminals	D.C. Resistance (ohms)
	51R-3 Receiver		
T-109	Audio output	1-2	800
		3-4	37
T-112	Discriminator transformer	1-2	110
		3-7	12
		5-7	40
		4-7	350
		6-7	380
T-113 and T-116	Input transformer	1-2	290
		3-4	7300
		5-6	7300

Symbol No.	Function	Terminals	D.C. Resistance (ohms)
T-114 and T-115	Output transformer	1-2 2-3 5-6 7-8 9-10 10-11	1200 1100 190 200 340 340
T-117	Saturable Reactor	1-2 2-3 4-5 5-6	5500 5500 8 8
Z-101	High pass filter	---	Infinite, all pins to each other.
Z-102	Antiresonant filter	Terminals	40
Z-103	Filter reactor	1-5	19,000
Z-105	90 cps filter	1-2 3-4	180 Infinite
Z-106	150 cps filter	1-2 3-4	180 Infinite
	Type 416N-1, 2 Power Supply		
L-301 and L-801	Filter reactor	1-2	25
L-302 and L-802	Filter reactor	1-2	200
	Type 416N-4 Power Supply		
L-301		1-2	25
L-302		1-2	200
T-301		SEC(TOTAL) PRI(TOTAL) PRI(FIL to GND)	90 7 2
	Type 416N-5 Power Supply		
L-301, L-302 and T-301		1-2 1-2 1-2 3-4 5-6 6-7	25 200 3.2 0.1 38 42

Symbol No.	Function	Terminals	D.C. Resistance (ohms)
	Type 333B-1 Servo Amplifier		
T-601	Input	1-2 3-4 5-6	35 1400 1400
T-602	Saturable Reactor	1-2 2-3 4-5 5-6	4600 4600 7 7
T-603	Autotransformer	1-5 1-2 1-3 1-4	80 0.6 2 26


T-109
WHITE DOT
1
2
4
3
T-112
WHITE DOT
1
2
3
7
6
5
4
T-113 AND T-116
8
7
6
5
4
3
2
1
673 0281 00
ALTERNATE T113 AND T116
5
4
3
2
1
677 0476 00
T-114 AND T-115
6
5
7
4
11
8
3
9
2
10
1
WHITE DOT
T-117
1
6
2
WHITE DOT
5
4
3
Z-101
2
1
3
WHITE DOT
Z-103
WHITE DOT
5
1
4
2
3
Z-105, Z-106
1
2
3
4

VIEWED FACING TERMINAL END OF COMPONENT

Figure 6-10. Transformer and Filter Terminal Diagram.

SECTION 7

TROUBLE SHOOTING

7-1. SECTION ISOLATION.

In order to locate trouble in the shortest possible time, a logical testing routine should be followed. First, isolate the trouble to one of the following sections: receiver r-f and audio section, instrumentation section, power supply, Autopositioner. Autopositioner troubles generally manifest themselves in faulty tuning, and somewhat like power supply troubles are seldom obscure. However, troubles in the r-f section and the instrumentation section are generally concealed to the extent that a careful check of r-f sensitivity as outlined in Section 6, must be made to determine which section is faulty. Separate trouble shooting charts or steps are given for the r-f and audio section, the instrumentation sections, power supply, and Autopositioner in paragraphs 7-2 through 7-7. Table 7-1 below is useful in further isolating troubles that have been tentatively identified as instrumentation section troubles. Further reference to the chart dealing with the particular channel, paragraphs 7-3 through 7-5, will generally locate the more common troubles in the instrumentation section.

Table 7-1.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Erroneous readings on all instruments on VOR or localizer operation; no audio output on communication frequencies.	1. Faulty power supply.	1. Refer to power supply trouble shooting chart, Table 7-5.
2. Normal readings on all instruments; low audio output, or no audio output at all.	1. Faulty audio section.	1. Trouble shoot audio section. Check V-109, V-110, T-109, and their voltages.
3. Erroneous readings on ID-48 Deviation Indicator; low flag alarm current; 337A-2 Omni-Bearing Indicator operating normally; normal audio output.	1. The manual reference channel is probably at fault since it is the only channel which is not common to both ID-48 Deviation Indicator and 337A-2 Omni-Bearing Indicator.	1. Refer to paragraph 7-3 for methods of further isolating the trouble.
4. Erroneous readings on 337A-2 Omni-Bearing Indicator; normal indications on ID-48 Deviation Indicator and the flag alarm indicators. Normal audio output.	1. The automatic channel is probably at fault since it is the only channel not associated with the ID-48 Deviation Indicator and 336A-2 Omni-Bearing Selector.	1. Refer to paragraph 7-4 for methods of further isolating the trouble.

Table 7-1. (cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
5. Erroneous readings on all instruments and flag alarm. Normal audio output.	1. The only circuits common to all instruments are the variable channel and that part of the reference channel on the input side of resolver amplifiers.	1. Refer to paragraphs 7-3 and 7-4 for methods of further isolating the trouble.
6. 332C-1 Radio Magnetic Indicator and 337A-2 Omni-Bearing Indicator rotate continuously.	1. No VOR signal.	1. Check reference signal through V-123 to T-116. Check variable signal through to cathode of V-124.
7. Reciprocal Error (observed by rotating selector knob for exactly 180° MAGNETIC BEARING change) greater than approximately 1/2°.	1. Excessive distortion in reference or variable phase channel; especially third harmonic.	1. Replace V-119, V-120, V-121, or V-122.
	2. Unsatisfactory filtering action in Z-103 C-187 assembly.	2. Check filter for typical response. See Section 9, paragraph 9-5.
8. Unbalanced TO-FROM indication.	1. Faulty rectifier CR-103 or CR-104.	1. Replace rectifiers.

7-2. RECEIVER R-F SECTION.

NOTE

> Before undertaking any of the trouble shooting steps below for the r-f section, make a visual inspection for obvious mechanical faults such as sticking slug racks, weak or broken springs on slug racks, broken slugs, loose or unmeshing gears, broken leads, solder shorts and overheated resistors. Check tubes V-101 through V-108 and V-111 through V-113. If low sensitivities appear to be the only trouble realign before proceeding further.

Troubles in the receiver r-f section can be located more readily by following the procedure below:

a. Measure sensitivities at the antenna (J-101) and the 1st mixer (V-102, pin 1) with a variable i-f signal and at the 2nd mixer (V-104, pin 1) with a fixed i-f signal. Compare sensitivities obtained with those given in Section 6. This will isolate the trouble to the r-f, variable i-f, fixed i-f or detector section of the receiver. If the sensitivities observed to this point are all low, check the detector stage for proper operation.

b. To isolate trouble to one of the two oscillator-injection systems make sensitivity measurements at the 1st mixer (V-102, pin 1) using the frequency that the receiver is tuned to, and at the 2nd mixer (V-104, pin 1) using a variable i-f frequency that corresponds to the receiver tuned frequency. (See Table 4-1, Section 4.)

c. Check operation of the fine frequency oscillator, V-113, by measuring the negative voltage at the grid of V-113, pin 1. This voltage will vary with crystal activity and is a good indication of low or faulty crystal action. If all fine frequency positions are inoperative or erratic check fine frequency crystal switch synchronization.

d. Check operation of the coarse frequency oscillator and injection system by measuring the negative voltage at the grid of the first mixer (V-102, pin 1) with no signal input to the receiver. Oscillator action can be checked by measuring the negative voltage at V-112, pin 7. This voltage will vary with crystal activity and is a good indication of faulty or low crystal action. If all course frequency positions are inoperative or erratic, check the coarse frequency crystal switch synchronization. Check the alignment of T-111, T-118, and L-102. V-112 will not oscillate if L-

102 is considerably detuned.

e. After isolating the trouble to a particular section of the r-f section isolate it to the faulty stage by making sensitivity, voltage, and resistance measurements at each stage of the section.

7-3. VOR MANUAL AND AUTOMATIC CIRCUIT.

Troubles in the manual or automatic circuits can be located readily by reference to the chart below.

Table 7-2.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Cannot carry out manual tracking control (R-180) adjustment due to apparent lack of range of R-180.	1. Defective capacitor in Z-104A between terminals A and 2. Should be .02 mf ±2%.	1. Replace Z-104. See Section 9., paragraph 9-6.
	2. Defective resistor in Z-104A between terminals 1 and A. Should be 256,000 ohms ±1%.	2. Replace Z-104. See Section 9., paragraph 9-6.
	3. Defective potentiometer R-180. Should be at least 20,000 ohms end to end at room temperature.	3. Replace R-180.
2. Cannot carry out automatic tracking control (R-207) adjustment due to apparent lack of range of R-207.	1. Defective capacitor in Z-104B between terminals B and 6. Should be .02 mf ±2%.	1. Replace Z-104. See Section 9, paragraph 9-6.
	2. Defective resistor in Z-104B between terminals B and 5. Should be 256,000 ohms ±1%.	2. Replace Z-104. See Section 9., paratraph 9-6.
	3. Defective potentiometer R-207. Should be at least 20,000 ohms end to end at room temperature.	3. Replace R-207.
3. Cannot obtain typical or minimum performance accuracy on instrument indications.	1. Open inductor in Z-102.	1. Replace Z-102.
	2. Defective filter circuit in power supply. *	2. Check resonant frequency of filter circuit. Replace defective inductor or capacitors as required.
	3. Defective decoupling capacitor C-186A, C-166C, C-162A or C-162B.	3. Replace defective capacitor.
	4. Relay K-105 contacts T1 and T3 not separated as they should be for omni-range operation.	4. Repair contacts, replace wafer, or replace relay. See Section 9., paragraph 9-3.

* Inductor L-302 and capacitors C-301, C-302 form a series resonant trap at 30 cps. This circuit should be resonant at 30 cps within ±4%, and should have an equivalent ac resistance not to exceed 60 ohms at room temperature.

Table 7-2. (cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
4. Erratic indication on instruments.	1. Defective limiter tubes V-116 or V-117.	1. Replace V-116 or V-117.
	2. Intermittent rectifier CR-101.	2. Replace CR-101.
	3. Intermittent short or open in C-166C.	3. Replace C-166.
	4. Oscillation in fixed i-f amplifier.	4. Refer to receiver r-f section trouble shooting, paragraph 7-2.
	5. Intermittent C-187 assembly.	5. Replace C-187. See paragraph 9-5.
	6. Intermittent tuning capacitor in Z-103 assembly.	6. Isolate by disconnecting external jumper between terminals 2 and 5. Retune with an external 8200 mmf capacitor. Replace Z-103.
	7. Defective variable phase amplifier tube, V-121.	7. Replace V-121.
	8. Defective auto injection tube V-126.	8. Replace V-126.
5. Cannot properly zero ID-48 Deviation Indicator by means of VOR ZERO control (R-198) and/or adjustable link between terminals 4 and 5 of C-187 and/or jumper at R-157.	1. Defective capacitor or inductor in Z-103.	1. Replace Z-103.
	2. Transformers T-114 or T-115 partially detuned.	2. Isolate by observing phase angle difference between grid and plate terminals of V-120 or V-122. This should not exceed 3 degrees. Replace transformer. See Section 6.

7-4. AUTOMATIC CIRCUIT.

Trouble in the automatic circuit can be located more readily by reference to the chart below.

Table 7-3.

SYSTEM	PROBABLE CAUSE	REMEDY
1. Type 337A-2 Omni-Bearing Indicator hunts about the proper indication.	1. Resistor R-230 open circuit.	1. Replace R-230.
2. Type 337A-2 Omni-Bearing Indicator very sluggish.	1. C-194 open or partially open.	1. Replace C-194.
	2. Reference and/or variable phase signal levels low resulting in insufficient reactor T-117 current. Should be approximately 40 volts across R-220.	2. Check tubes. Check voltages. See figure 7-1.
	3. Motor phasing capacitor C-199 open or shorted. When the motor is running the phase relationship of the voltage across phase one with respect to phase two should be approximately 90°.	3. Check phase relationship. Will appear as a circle when observed on an oscilloscope. Replace defective C-199.
3. Type 337A-2 Omni-Bearing Indicator cannot be balanced to proper course with AUTO CENTER control, R-225.	1. Defective V-124 or V-125.	1. Replace V-124 or V-125.
	2. Excessive leakage in C-192 or C-193 resulting in unwanted biasing action on grid 7 or 2 of V-125.	2. Replace C-192 or C-193.
	3. Defective resistor in Z-104B between terminals B and 8.	3. Replace Z-104. See Section 9., paragraph 9-6.
	4. Defective capacitor in Z-104B between terminals 7 and 8.	4. Replace Z-104. See Section 9., paragraph 9-6.
4. Type 337A-2 Omni-Bearing Indicator rotates continuously with no apparent relation to aircraft position or 479S-3 Signal Generator PHASE ANGLE SELECTOR reading.	1. 400 cps power applied to Type 337A-2 Omni-Bearing Indicator motor but no dc power applied to receiver.	1. Check power source, plugs, and power switches

Table 7-3. (cont.)

SYSTEM	PROBABLE CAUSE	REMEDY
5. Type 337A-2 Omni-Bearing Indicator rotates continuously at very slow speed.	1. Loss of either reference or variable phase signals.	1. Refer to voltage measurement diagram, and trace signal through proper channel to source of trouble.
6. Cannot obtain typical or minimum performance accuracy on Type 337A-2 Omni-Bearing Indicator.	1. This difficulty can often be traced to abnormal distortion. Check tubes V-124, V-125, V-126. If accuracy does not improve, check T-116. It should be accurately resonated to 30 cps.	1. Check tubes, replace if necessary. If the phase angle difference across R-215 greatly exceeds about 2 degrees replace T-116. See Section 6.

7-5. LOCALIZER.

Troubles in the tone localizer circuits can be located more readily by reference to the chart below.

Table 7-4.

SYSTEM	PROBABLE CAUSE	REMEDY
1. Unable to obtain 90 microamperes deflection at ±4 db points on 479S-3 Signal Generator. See Section 6.	1. Weak tubes V-121 or V-122. (This would also affect omnirange operation.)	1. Replace tubes.
	2. K-105 contact T1 not released as it should be for tone localizer operation.	2. Repair contact or replace wafer.
2. Unable to center deviation indicator by means of LOC CENTERING control (R-236)	1. K-105 contact T10 not released as it should be for tone localizer operation.	1. Repair contact or replace wafer. See paragraph 9-3, Section 9
	2. Defective filter Z-105 or Z-106. A defective Z-105 will cause deviation indicator to deflect to left. A defective Z-106 will cause deflection to right.	2. Replace Z-105 or Z-106.

7-6. POWER SUPPLY.

Troubles in the 416N Power Supplies may be located more readily by reference to the chart below.

Table 7-5.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Failure to start.	1. No voltage or improper input voltage.	1. Check battery voltage and replace battery if necessary.
	2. "Open" in input circuit wiring or power cable.	2. Check and repair "opens" and loose connections in input circuit.
	3. Defective starting switch.	3. Replace or repair switch.
	4. Armature winding may be "open".	4. Return dynamotor to qualified overhaul depot.
	5. Worn low voltage brushes.	5. Replace brushes as outlined in Section 9., paragraph 9-26.
	6. Dirty low voltage commutator	6. May be due to grease on commutator. Clean with cloth saturated with gasoline or dress the commutator.
2. Excessive speed.	1. Shunt field may have short circuited turns or an "open".	1. Replace dynamotor.
3. No output, or low output.	1. Poor commutation resulting from a dirty commutator.	1. Clean commutator with cloth saturated with gasoline, or dress the commutator. See paragraph 9-26.
	2. Low input voltage.	2. Check input circuit for loose connections. Check battery voltage.
	3. Shims "end loading" bearings.	3. See paragraph 9-26.
	4. Defective armature.	4. Replace armature.
	5. Broken or sticking brushes	5. Replace brushes.
4. Dynamotor noisy mechanically.	1. Dry bearings.	1. Remove bearings and lubricate or replace as necessary.

Table 7-5. (cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
4. (Cont.)	2. Bent shaft.	2. Replace armature.
	3. High commutator bar.	3. See paragraph 9-26.
	4. Dynamotor mounting not secure.	4. Tighten mounting screws.
5. Overheating.	1. Bearings dry or damaged.	1. Remove bearings and lubricate or replace as necessary.
	2. Shims "end loading" bearings.	2. See paragraph 9-26.
	3. Bent shaft rubbing against housing.	3. Replace armature.
	4. Sticking brushes.	4. Replace brushes.
6. Dynamotor noisy electrically.	1. Arcing at brushes.	1. Replace brushes.
	2. Broken or cracked brushes.	2. Replace brushes.
	3. Brushes sticking in holder.	3. Replace brushes.
	4. High commutator bar.	4. See paragraph 9-26.
	5. Dirty commutator.	5. Clean commutator with clean cloth saturated with unleaded gasoline.
7. Vibration.	1. Bent shaft.	1. Straighten shaft.

7-7. AUTOPOSITIONER.

Troubles in the Autopositioner system may be located more readily by reference to the chart below. A thorough study of the Autopositioner system, Section 4, paragraphs 4-15 through 4-23 should be made before Autopositioner trouble shooting is undertaken.

Table 7-6.

SYSTEM	PROBABLE CAUSE	REMEDY
1. Motor continues to run after Autopositioner sets up.	1. Contacts bent on K-101, K-102.	1. Straighten contacts.
	2. Spring weak, pawl does not seat fully.	2. Replace solenoid, replace spring or remove and bend spring to increase tension.

Table 7-6. (cont.)

SYSTEM	PROBABLE CAUSE	REMEDY
1. (Cont.)	3. Seeking switch out of synchronization, causing pawl to drop late and catch on far side of notch and not seat fully.	3. Adjust switch. See Section 9., paragraph 9-25.
	4. Intermittent or continuous short to ground on negative side of motor.	4. Remove cause of short.
2. Autopositioner sets up on wrong channel occasionally.	1. Broken wire or poor connection on one or more control wires.	1. Note which channels give ambiguous results. From figure 12-7 note which wire is designed to differentiate between these ambiguous channels. This wire is probably open. Find open circuit and correct cause.
	2. Open circuit between ground and front side of remote switch.	2. Note whether Autopositioner sets up on wrong channel for which the code given in figure 12-7 is exactly opposite to code for proper channel. This indicates no ground on remote switch Check by gounding front blade (by means of long clip) on remote switch when Autopositioner sets up improperly. Find open circuit and correct cause.
	3. Relay K-103 may be operating improperly.	3. Check wire J, relay contacts, and wiring to switch S-104. Relay K-103 should be energized on all odd megacycles, open on even megacycles
3. Autopositioner sets up on some channels, runs continuously on others.	1. Control wire shorted to ground.	1. From code given in table on figure 12-7, note whether one wire is supposed to be grounded on the channels that operate properly and ungrounded (cont.)

Table 7-6. (cont.)

SYSTEM	PROBABLE CAUSE	REMEDY
3. (cont.)		on the others. This wire is probably shorted to ground. Remove causes of short.
	2. Control wires shorted to each other.	2. From code given in the table on figure 12-7, note whether two or more wires are supposed to have same connections (both grounded or both ungrounded) on all channels that operate connections on all other channels. These wires are probably shorted. Remove cause of short.
	3. Switch out of synchronization, allowing pawl to drop too early or too late on some channels.	3. Check visually when set up. Realign as necessary. See paragraph 9-25.
4. Autopositioner does not set up on any channel, stop wheel turns freely, solenoid opens momentarily each revolution of shaft.	1. Spring bent, pawl does not engage stop wheel with sufficient force to hold.	1. Replace solenoid, replace spring, or remove and bend spring to increase tension.
	2. Switch out of synchronization.	2. Realign switch. See paragraph 9-25.
	3. Pawl sticks on its pivot.	3. Remove solenoid. Remove pawl and clean pivot pin. Reassemble pawl and lubricate pivot with AN-O-4 oil. Replace and align solenoid.
	4. Solenoid shifted. Does not allow pawl to seat properly.	4. Realign solenoid. See paragraph 9-22.
	5. Pawl tip shape altered severly; does not hold.	5. Remove solenoid. Replace pawl with new pawl. Reassemble and readjust solenoid.
5. Autopositioner does not set up on any channel, stop wheel turns freely, solenoid remains energized continuously.	1. Wire from solenoid to seeking switch grounded.	1. Find and remove cause of ground.
	2. Rear switch blade of seeking switch grounded by short between rear and front blades.	2. Find and remove cause of short. Replace switch if necessary.
	3. Several or all control wires shorted to ground.	3. Find and remove cause of short.

Table 7-6. (cont.)

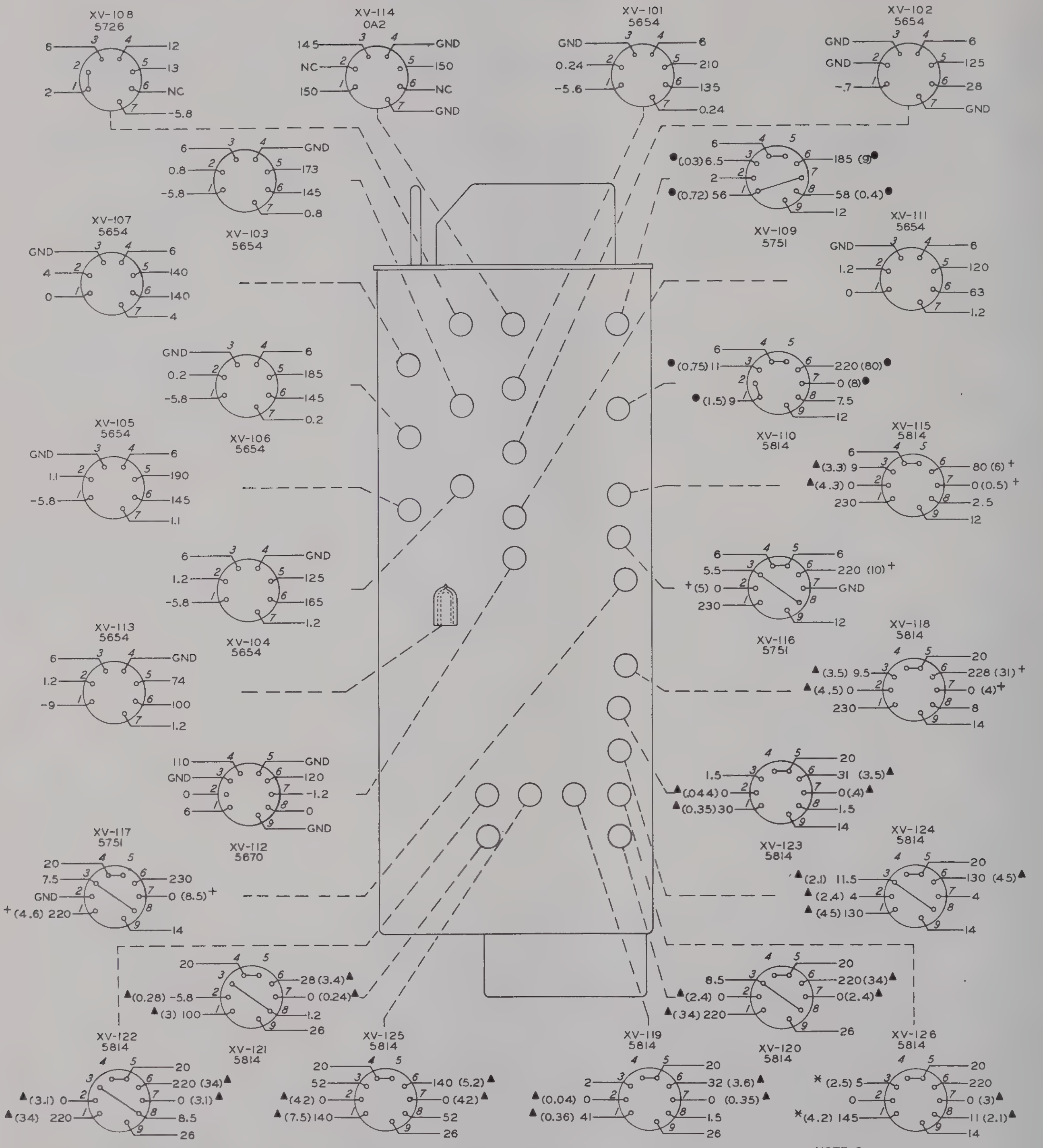
SYSTEM	PROBABLE CAUSE	REMEDY
5. (cont.)	4. Rear blade of control switch grounded, possibly by short between rear and front blades.	4. Find and remove cause of short. Replace switch if necessary.
6. Autopositioner does not set up, stop wheel does not turn freely, solenoid energized, motor runs.	1. Pawl does not lift clear of notch. Relay shifted away from pawl.	1. Realign solenoid. See paragraph 9-22.
	2 Pawl does not lift clear of notch. Solenoid has insufficient travel.	2. Readjust.
	3. Driven elements jammed by physical obstruction.	3. Find and remove obstruction.
	4. Gears jammed.	4. Find and remove cause of jam.
	5. Autopositioner or driven element bearings out of alignment, binding shaft.	5. Realign shaft.
	6. Pawl sticks on its pivot.	6. Remove solenoid and pawl. Clean pawl and pivot pin. Replace pawl and lubricate pivot with AN-O-4 oil. Replace and realign solenoid.
	7. Improper lubrication on bearings at low temperature.	7. Disassemble and clean bearings as required. Lubricate in accordance with lubrication chart.
	8. Insufficient clutch torque, due to broken clutch springs.	8. Disassemble. Replace springs. Reassemble and realign. See paragraph 9-24.
	9. Insufficient clutch torque due to glazing of clutch surfaces.	9. Disassemble. Replace clutch drum and clutch shoe assembly. Reassemble and realign.
7. Autopositioner sets up, then recycles by itself.	1. Spring bent, does not hold pawl in notch properly.	1. Remove spring. Carefully bend spring to increase tension. Reassemble and readjust solenoid air gap.
	2. Solenoid shifted. Pawl does not seat fully.	2. Realign solenoid. Check and readjust air gap if necessary.

Table 7-6. (cont.)

SYSTEM	PROBABLE CAUSE	REMEDY
7. (cont.)	3. Pawl tip altered, excessive slope or radius causes pawl to be pushed out of slot.	3. Remove solenoid. Replace pawl with new pawl. Reassemble and adjust solenoid.
	4. Intermittent short circuit between control wires or from wires or switch to ground.	4. Find and remove cause of short.
	5. Switch out of synchronization operation marginal.	5. Realign switch. See paragraph 9-25.
	6. Broken control wire or intermittent open circuit may allow Autopositioner to set up on wrong channel, then close circuit momentarily to drive Autopositioner on to proper channel.	6. Find and correct cause of open circuit.
8. Autopositioner solenoid closes, motor does not operate.	1. Relay contacts bent, not closing motor circuit.	1. Adjust contacts.
	2. Open circuit from relay to motor.	2. Find and correct cause of open circuit.
	3. Moving contact not grounded properly to frame, or frame to panel.	3. Find and correct cause of open circuit. Clean contact surfaces.
	4. Contacts dirty.	4. Clean or replace contacts. Check contact adjustment and readjust to obtain proper contact spacing and pressure.
	5. Moving contact bent or temper lost as result of short circuit, not sufficient contact pressure.	5. Readjust or replace contact.
	6. No power on positive side of motor.	6. Find and correct cause of open circuit.
	7. Motor armature burned out.	7. Replace motor. See paragraph 9-20.
	8. Reduction gears jammed. Check by turning manually.	8. Find and remove obstruction.

Table 7-6. (Cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
9. Autopositioner solenoid does not operate.	1. No power on positive side of solenoid.	1. Find and correct cause of open circuit.
	2. Open circuit from solenoid to seeking switch.	2. Find and correct cause of open circuit.
	3. Control wire circuit open.	3. Find and correct cause of open circuit.
	4. Solenoid coil burned out.	4. Replace solenoid coil. See paragraph 9-22.
	5. No air gap on solenoid.	5. Readjust air gap.


XV-108
5726
6
12
13
NC
2
-5.8
XV-114
0A2
145
GND
NC
150
150
NC
GND
XV-101
5654
GND
6
0.24
210
-5.6
135
0.24
XV-102
5654
GND
6
GND
125
-.7
28
GND
6
GND
0.8
173
-5.8
145
0.8
XV-103
5654
6
●(03) 6.5
185 (9)●
2
●(0.72) 56
58 (0.4)●
12
XV-109
5751
XV-107
5654
GND
6
4
140
0
140
4
XV-111
5654
GND
6
1.2
120
0
63
1.2
GND
6
0.2
185
-5.8
145
0.2
XV-106
5654
6
●(0.75) 11
220 (80)●
0 (8)●
●(1.5) 9
7.5
12
XV-110
5814
XV-105
5654
GND
6
1.1
190
-5.8
145
1.1
XV-115
5814
6
▲(3.3) 9
80 (6) +
▲(4.3) 0
0 (0.5) +
230
2.5
12
6
GND
1.2
125
-5.8
165
1.2
XV-104
5654
6
5.5
6
220 (10) +
+(5) 0
GND
230
12
XV-116
5751
XV-113
5654
6
GND
1.2
74
-9
100
1.2
XV-118
5814
20
▲(3.5) 9.5
228 (31) +
▲(4.5) 0
0 (4) +
230
8
14
110
GND
GND
120
0
-1.2
6
0
GND
XV-112
5670
1.5
20
31 (3.5)▲
▲(.044) 0
0 (4)▲
▲(0.35) 30
1.5
14
XV-123
5814
XV-117
5751
20
7.5
230
GND
0 (8.5) +
+(4.6) 220
14
XV-124
5814
▲(2.1) 11.5
20
130 (4.5)▲
▲(2.4) 4
4
▲(4.5) 130
14
20
28 (3.4)▲
▲(0.28) -5.8
0 (0.24)▲
▲(3) 100
1.2
26
XV-121
5814
8.5
20
220 (34)▲
▲(2.4) 0
0 (2.4)▲
▲(34) 220
26
XV-120
5814
XV-122
5814
20
▲(3.1) 0
220 (34)▲
▲(34) 220
0 (3.1)▲
8.5
26
XV-125
5814
20
52
140 (5.2)▲
▲(4.2) 0
0 (4.2)▲
▲(7.5) 140
52
26
XV-119
5814
2
20
▲(0.04) 0
32 (3.6)▲
▲(0.36) 41
0 (0.35)▲
1.5
26
XV-126
5814
*(2.5) 5
20
0
220
*(4.2) 145
0 (3)▲
11 (2.1)▲
14

NOTE 1

CONDITIONS OF MEASUREMENT:

RF INPUT: 1000 UV SIGNAL AT 114.9MC NORMAL VOR SIGNAL MODULATED AT 1000 CPS.

DC INPUT: 26.5 VOLTS.

AC INPUT: 26.5 VOLTS. 400 CPS.

AC MEASUREMENT: MEASURED TO GROUND WITH BALLANTINE MODEL 300 VOLTMETER WITH SHORT UNSHIELDED LEADS.

DC MEASUREMENT: MEASURED TO GROUND WITH HEWLITT PACKARD MODEL 410A VOLTMETER.

SIGNAL SOURCE: SIGNAL GENERATOR SG-1/ARN AND MODULATOR MD-83/ARN.

CONTROL SETTINGS: SQUELCH (R-150) MAXIMUM CLOCKWISE POSITION.

NOTE 2

+ INDICATES 9960 CPS

▲ INDICATES 30 CPS

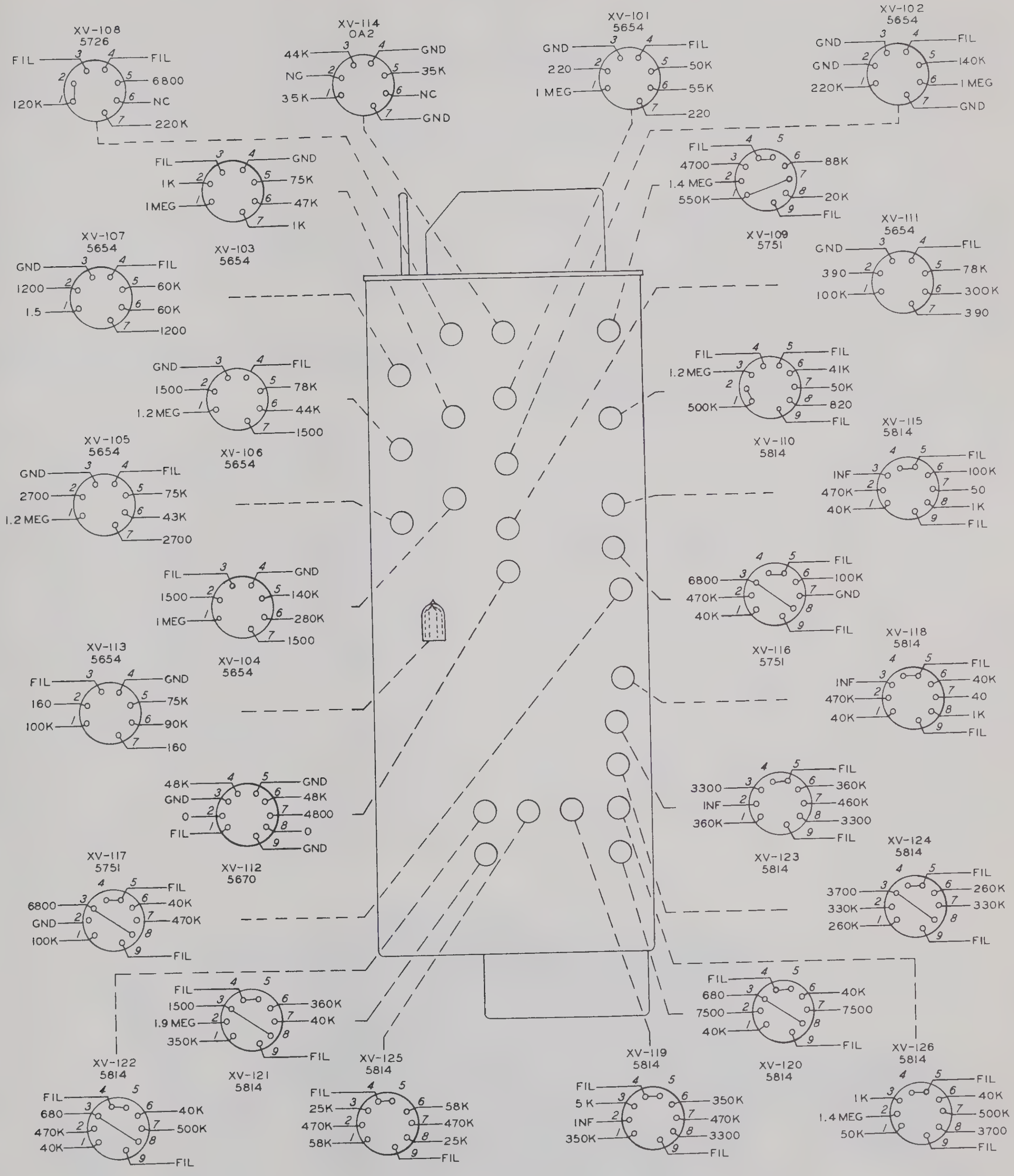
● INDICATES 1000 CPS

* INDICATES 60 CPS

NOTE 3

ALL AC VALUES IN PARENTHESIS ( )

Figure 7-1. Type 51R-3 Receiver, Voltage Measurements Diagram


XV-108
5726
FIL
FIL
6800
NC
220K
120K
XV-114
OA2
44K
NC
35K
GND
35K
NC
GND
XV-101
5654
GND
220
1 MEG
FIL
50K
55K
220
XV-102
5654
GND
GND
220K
FIL
140K
1 MEG
GND
XV-103
5654
FIL
1K
1MEG
GND
75K
47K
1K
XV-109
5751
FIL
4700
1.4 MEG
550K
88K
20K
FIL
XV-107
5654
GND
1200
1.5
FIL
60K
60K
1200
XV-111
5654
GND
390
100K
FIL
78K
300K
390
XV-106
5654
GND
1500
1.2 MEG
FIL
78K
44K
1500
XV-110
5814
FIL
1.2 MEG
500K
FIL
41K
50K
820
FIL
XV-105
5654
GND
2700
1.2 MEG
FIL
75K
43K
2700
XV-115
5814
INF
470K
40K
FIL
100K
50
1K
FIL
XV-104
5654
FIL
1500
1 MEG
GND
140K
280K
1500
XV-116
5751
6800
470K
40K
FIL
100K
GND
FIL
XV-113
5654
FIL
160
100K
GND
75K
90K
160
XV-118
5814
INF
470K
40K
FIL
40K
40
1K
FIL
XV-112
5670
48K
GND
0
FIL
GND
48K
4800
0
GND
XV-123
5814
3300
INF
360K
FIL
360K
460K
3300
FIL
XV-117
5751
6800
GND
100K
FIL
40K
470K
FIL
XV-124
5814
3700
330K
260K
FIL
260K
330K
FIL
XV-121
5814
FIL
1500
1.9 MEG
350K
360K
40K
FIL
XV-120
5814
FIL
680
7500
40K
40K
7500
FIL
XV-122
5814
FIL
680
470K
40K
40K
500K
FIL
XV-125
5814
FIL
25K
470K
58K
58K
470K
25K
FIL
XV-119
5814
FIL
5K
INF
350K
350K
470K
3300
FIL
XV-126
5814
1K
1.4 MEG
50K
FIL
40K
500K
3700
FIL

NOTE:

FIL ABBREVIATES FILAMENT
INF ABBREVIATES INFINITE
NC ABBREVIATES NO CONNECTION

CONDITIONS OF MEASUREMENTS

P-101 AND ANTENNA CABLE REMOVED FROM RADIO RECEIVER 51R-3. MEASUREMENTS MADE FROM TERMINALS INDICATED TO GROUND WITH A HEWLITT PACKARD MODEL 410A VOLTMETER. SQUELCH POTENTIOMETERS FULLY CLOCKWISE.

Figure 7-2. Type 51R-3 Reveiver, Resistance Measurements Diagram

SECTION 8

MAINTENANCE

8-1. PREFLIGHT INSPECTION.

To perform the following preflight inspection a vhf tower transmitter or omni-range must be located such that line-of-sight exists from the receiving antenna to the transmitting antenna.

a. Check vertical and horizontal needles and TO-FROM indicator for centering. Make certain both flag alarms are centered over their respective needles.

b. Turn master switch on.

c. Check mechanical operation of selector knob and TO-FROM switch on OBS.

d. Test marker light with PRESS to TEST switch.

e. Check security of mounting of shockmounts and of receiver in shockmount.

f. Check antenna coaxial cable for proper connection and tightness at receiver panel.

g. Inspect antenna for any obvious physical damage.

h. Set frequency of local vhf transmitter into the vertical window of the 314U - Control Unit. Note frequency set-up time. It should not exceed six seconds.

i. Identify station from coded signal in headset or tower traffic if present. Note if signal level is adequate.

8-2. 100 HOUR INSPECTION. (Line Check)

The check outlined below is performed with a Collins Type 479U-1 Signal Generator. It is intended as a "go, no-go" check for quickly determining the operating condition of the 51R-3 Receiver and its system. In this check the 479U-1 Signal Generator is directly connected to the 51R-3 Receiver using a 10 foot r-f cable. Although an alternate procedure using the antenna supplied with the 479U-1 Signal Generator and the 37J-2 Antenna on the aircraft may be used, complete receiver system testing using these two antennas is recommended only after signal strengths obtained outside the aircraft using these antennas are correlated with those obtained when the 479U-1 Signal Generator is directly connected to the 51R-3 Receiver. Such correlation must be carried out for each type of aircraft since the

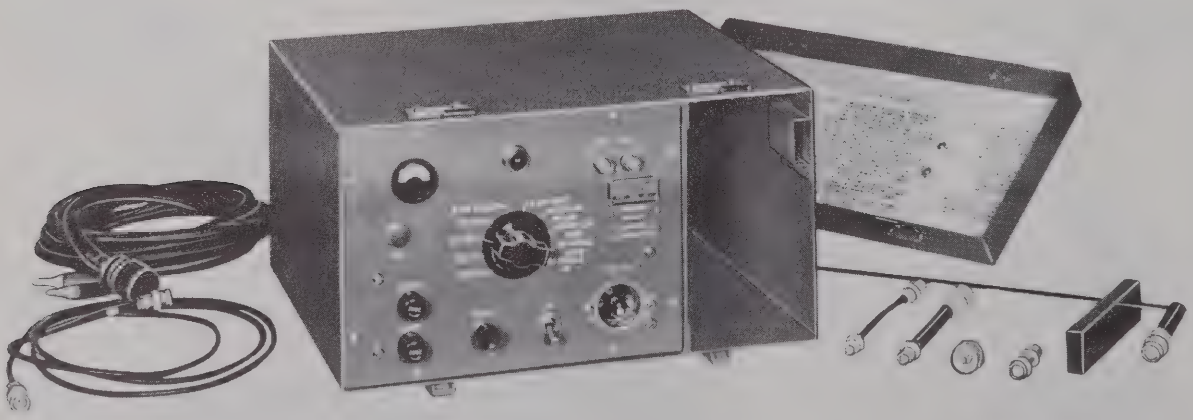


Figure 8-1. Type 479U-1 Signal Generator

location of the 37J-2 Antenna may vary with each type. Further, position of the 37J-2 Antenna with respect to the antenna on the 479U-1 Signal Generator must be specified and maintained for each type of aircraft. Unless this procedure is carefully adhered to, wide discrepancies in flag sensitivities may exist.

a. Connect r-f cable from RCVR connector on 479U-1 Signal Generator to the antenna connector on the front of the 51R-3 Receiver.

b. Connect 479U-1 Signal Generator to a source of power, turn on, and turn function selector to BUZZER position.

c. Check 51R-3 Receiver r-f circuits by rotating frequency selector on 314U - Control Unit. A 500-1000 cps note should be heard in the headset on all channels.

d. Select channels 112.1 or 112.5 on the 314U-Control Unit.

e. Turn function selector to VOR 0° position and turn OBS knob for centering of the vertical needle.

f. The OBS should read 0° ±5° FROM. The OBI and RMI should read 180° ±7°.

g. Turn function selector to VOR 315° position and OBS knob for centering of the vertical needle.

h. The OBS should read 315° ±5° FROM. The OBI and RMI should read 135° ±7°.

i. Turn function selector to VOR 150° position and OBS knob for centering of the vertical needle.

j. The OBS should read 150° ±5° FROM. The OBI and RMI should read 330° ±7°.

k. Turn function selector to 90/150 LOC YELLOW position and check receiver localizer operation by tuning receiver to 109.9 and 110.3 megacycles. Vertical needle should deflect between two and five dots to the right.

l. Turn function selector to 90/150 LOC BLUE position and tune receiver to 109.9 and 110.3 megacycles. Vertical needle should deflect between two and five dots to the left.

m. Check operation of 333B Servo Amplifier and compass repeating system by varying the reading of the remote indicating compass in some convenient manner and observing whether or not the RMI scale follows.

8-3. 479T-2 SIGNAL GENERATOR.

For customers who wish to provide a more complete check of VOR and localizer functions than may be obtained through the use of the 479U-1, Collins has developed the 479T-2 Signal Generator. Use of the 479U-1 for conducting the 100 hour inspection is described in paragraph 8-2. To familiarize technicians with the capabilities of the 479T-2 Signal Generator, several of the major differences between the 479T-2 and the 479U-1 are listed below.

Function	479T-2	479U-1
Frequency range	All frequencies in 0.1 mc steps from 108.0 to 135.9 and 329.3 to 335.0.	110.3, 112.5, 335.0 mc (alternate frequencies: 109.9, 112.1, 333.8 mc).
R-f output level	Continuously adjustable from 4 to 200,000 uv.	Not adjustable.
VOR azimuths	0° -45° -90° -135° -180° -225° -270° -315° (accurate to ±0.5°). Increment switch provides ±1° deviation from any selected azimuth.	0° -150° -315° (accurate to ±3.0°)
Tone localizer	Continuously adjustable db ratio control calibrated at 0, 6.0, and 7.5 db gives accurate centering and left and right deflection checks.	Provides fixed amount of cross-pointed deflection (2 to 5 dots) left and right. No provision for centering checks.
Audio checking facilities	1000 cps tone modulation on any selected frequency.	Buzzer provides audio modulation of wide band noise signal.

When conducting the 100 hour inspection using the 479T-2 Signal Generator, the following procedure is advised.

8-4. 100 HOUR INSPECTION USING 479T-2.

The check outlined below is intended to quickly determine the operating condition of the 51R-3 Receiver and its system. It is recommended that the 479T-2 be connected directly to the 51R-3 Receiver using the 10 foot r-f cable supplied with the 479T-2. Although an alternate procedure using the antenna supplied with 479T-2 Signal Generator and the 37J Antenna on the aircraft is possible, complete receiver system testing using this procedure is recommended only after signal strengths obtained are correlated with those produced with the 479T-2 Signal Generator directly connected to the 51R-3 receiver. Such correlation must be carried out for each type of aircraft since the location of the 37J Antenna will vary. Further, the position of the 37J Antenna with respect to the antenna on the 479T-2 must be specified and maintained for each aircraft. Unless this procedure is carefully adhered to, wide discrepancies in flag sensitivity may exist.

a. Connect r-f cable from NAV connector on 479T-2 Signal Generator to the antenna connector on the 51R-3 Receiver.

b. Turn SET LINE TO 21V control on 479T-2 to OFF position.

CAUTION

To avoid damaging the equipment, be certain that the SET LINE TO 21V control is placed in the OFF position before connecting the source of power.

c. Connect the power cord supplied with the 479T-2 between the 21V DC - 29 V DC connector on the signal generator and a source of 21 - 29 volt power.

d. Turn METER switch to the LINE position and adjust the SET LINE TO 21 V switch until the meter reads 21 ± 0.5 volts.

e. Turn METER switch to B+ position and read B+ voltage on the meter. Reading should be 230 volts. Allow 3 minutes warm-up.

f. With METER switch in CAR position, and CARRIER SET control fully counterclockwise, adjust METER ZERO control until meter reads zero. This adjustment is not critical. The meter may be off zero by several divisions with only a small error in r-f attenuator calibration.

g. Set NAV - GS switch to NAV position.

h. Select desired VOR frequency on MEGACYCLES selector switch. Set 51R-3 Receiver to same channel.

i. With the METER switch in the CAR position, set meter to red line with CARRIER SET control. Set MICROVOLTS control to 1000 microvolts.

j. Select an omni-bearing of 0° on the VOR switch. Center the vertical bar of the ID-48 Deviation Indicator with the control on the Omni Bearing Selector. The OBS should read $0^{\circ} \pm 3^{\circ}$ FROM. The OBI and RMI should read $180^{\circ} \pm 4^{\circ}$. Rotate the OBS 180 degrees and observe whether TO-FROM indication changes to TO.

k. Repeat step j. for omni-bearing settings of 45°, 90°, 135°, 180°, 225°, 270° and 315°. The OBS reading should be the same as the omni-bearing setting $\pm 3^{\circ}$. The TO-FROM indicator should read FROM. The OBI and RMI should read the reciprocal course $\pm 4^{\circ}$.

l. Test the OBI and Deviation Indicator sensitivity to small omni-bearing changes by selecting an omni-bearing with the VOR switch and centering the vertical bar of the Deviation Indicator. Place ±1 DEGREE switch alternately in + and - positions and note deflection of the vertical bar of the Deviation Indicator. The vertical bar should deflect an amount corresponding to 15 microamperes to either side. A bearing change should occur on the OBI. Tap instrument lightly if engines are not operating.

m. Place the AUDIO SELECTOR switch in the 1000 ∿ position and listen for a tone in the receiver headset.

n. Turn AUDIO SELECTOR to TONE LOC. The NAV-GS switch should be in the NAV position.

o. Set 479T-2 Signal Generator and the 51R-3 Receiver to the desired channel in the localizer band. Set meter to red line with CARRIER SET control.

p. Rotate the LOC-GS control over the range between the two engraved lines on the left sector and note the amount of left deflection on the cross pointer. The vertical bar should deflect to the extreme left dot (150 microamperes) on such instruments as Deviation Indicator ID-48A or Course Indicator 331A-1 as the LOC-GS control is varied within this range. (The course bar of Course Indicator 311A-1 is equivalent to the cross pointer).

NOTE

Tests in paragraphs p. and q. are based on a standard localizer receiver sensitivity of 90 microamperes deflection for a 4 db ratio between tones.

q. Rotate the LOC-GS control over the range between the two engraved lines on the right sector and note the deflection of the vertical bar on the Deviation Indicator. The vertical bar should deflect as described in paragraph p. except the deflection should be to the right.

t. Check vertical bar centering by turning the LOC-GS control to the white center sector. The vertical bar should be centered when the LOC-GS control is within this sector.

8-5. 500 HOUR INSPECTION. (Bench Check)

a. Remove the following components to a test bench:

51R-3 Receiver
416N Power Unit
351A-1 Accessory Frame
333B-1 Servo Amplifier
314U-Control Unit
ID-48 Deviation Indicator
336A-2 Omni-Bearing Selector
337A-2 Omni-Bearing Indicator

b. Remove the cases and covers of all components and clean the inside of each with a gentle jet of air.

c. Check the general physical condition of all internal parts. Look for mechanical damage, overheated resistors, loose parts, corrosion, dry gears, and any other condition that would lead to malfunctioning of the equipment.

d. Check relay contacts for burning, pitting and dirt. Resurface burned or pitted contacts with a burnishing tool. Clean dirty contacts with a clean cloth soaked in carbon tetrachloride.

e. Lubricate as follows:

Table 8-1.

AN-G-25 GREASE

Part	Location	Amount
Autopositioner gear train	Front of receiver	Small amount to each gear
Gear driving low frequency crystal selector mechanism	Side of fine frequency oscillator housing	Small amount to each gear
Dynamotor bearings	Each end of unit	Small amount

AN-O-4 OIL (AN-O-6A, Alternate)

Part	Location	Amount
Coarse frequency shaft coupler	Front end coarse frequency tuner	One drop
Autopositioner pawl pivot pin	(4), figure 9-10	One drop
Coarse frequency slug rack oil retainer washers	Each end coarse frequency tuner	One drop
Oilite bearings in coarse and fine frequency tuner frames	One each end of tuner frames	One drop each bearing
Oilite bearings in fine frequency crystal selector gear train	Side of fine frequency oscillator housing	One drop each bearing

f. Check dynamotor brushes for a minimum length of 1/4". Replace if necessary. A minimum brush length of 1/4" is necessary for successful operation.

g. Check brushes on Autopositioner motor for a minimum length of 1/8".

h. Check the dynamotor commutators for signs of grooving or pitting. Replace or dress if necessary. Slight grooving of the commutators is not abnormal after several hundred hours of operation.

i. Check performance of receiver using 479S-3 Signal Generator as detailed in paragraph 6-10. Realign if necessary.

j. Reassemble and reinstall all components removed in step a.

8-6. PROVISION FOR FUTURE FREQUENCY ALLOCATION CHANGES.

Switching employed in the 51R-3 receiver has been designed to allow a flexible and easily adopted method of changing VOR-ILS allocations should this be desirable in the future. An 8-pin terminal board, TB-102, is mounted on the front panel accessible under the front dust cover. (See figure 12-43.) This terminal board is wired, in conjunction with the necessary switching, such that any of eight VOR-ILS allocations, now under discussion, can be easily implemented by bridging the appropriate terminal points on this board with bus wire. (See Table 8-2 below.) In the case of three allocations, the addition of two wires from the terminal board to relay K-103 located adjacent to this board is necessary. The receiver is shipped with bus wire jumpering corresponding to the system in use at the time of shipment. (System E for original shipments.)

Table 8-2.

System	Omni-Range Frequencies	Tone Localizer Frequencies	Jumper Pins on TB-102	Also Connect
A	112.0 to 117.9 mc and even .1 mc from 108.0 to 111.8 mc.	Odd .1 mc from 108.1 to 111.9 mc.	C and G to H and D to F	
B	111.0 to 117.9 mc and even .1 mc from 108.0 to 110.8 mc.	Odd .1 mc from 108.1 to 110.9 mc.	A to C to E to G and D to F	TB-102-G to K-103-2 and TB-102-H to K-103-3
C	110.4 to 117.9 mc and even .1 mc from 108.0 to 110.2 mc	Odd .1 mc from 108.1 to 110.3 mc.	A and C to G and D to F	TB-102-E to K-103-3 and TB-102-H to K-103-2
D	110.0 to 117.9 mc and even .1 mc from 108.0 to 109.8 mc	Odd .1 mc from 108.1 to 109.9 mc	A and C to G and D to F	
E	112.0 to 117.9 mc	108.0 to 111.9 mc	D to H	
F	111.0 to 117.9 mc	108.0 to 110.9 mc	A to D	TB-102-D to K-103-2 and TB-102-H to K-103-3
G	110.4 to 117.9 mc	108.0 to 110.3 mc	A, B and D to F and H to E	
H	110.0 to 117.9 mc	108.0 to 109.9 mc	A to D	

SECTION 9

REPAIR AND OVERHAUL

9-1. REMOVAL OF 90/150 CPS FILTER UNIT.

a. Remove two 6-32 securing screws and slip dust cover off to the rear.

b. See figure 12-37 for location of Z-105 and Z-106. Remove wires from filter to be removed and dress wires out of the way.

c. Remove three #6 screws located at the three corners of the filter mounting plate. Remove hexagonal standoff at top corner of filter mounting plate adjacent to Z-106. This will loosen entire unit and allow it to be rotated and laid on top surface of receiver.

d. On back surface of mounting plate are four screws (2 per filter) that must be removed to replace filters.

e. When replacing filter applique unit liquid staking compound must be used at stud to which standoff of c. above secures.

f. Localizer and phase centering controls R-236, R-240, also located within applique unit, are removed by unsoldering three connections to each control. After unsoldering, loosen shaft mounting nut and remove control from its slotted mounting hole by moving toward the rear.

9-2. REMOVAL OF HINGED CONTROL AND CAPACITOR MOUNTING PANEL.

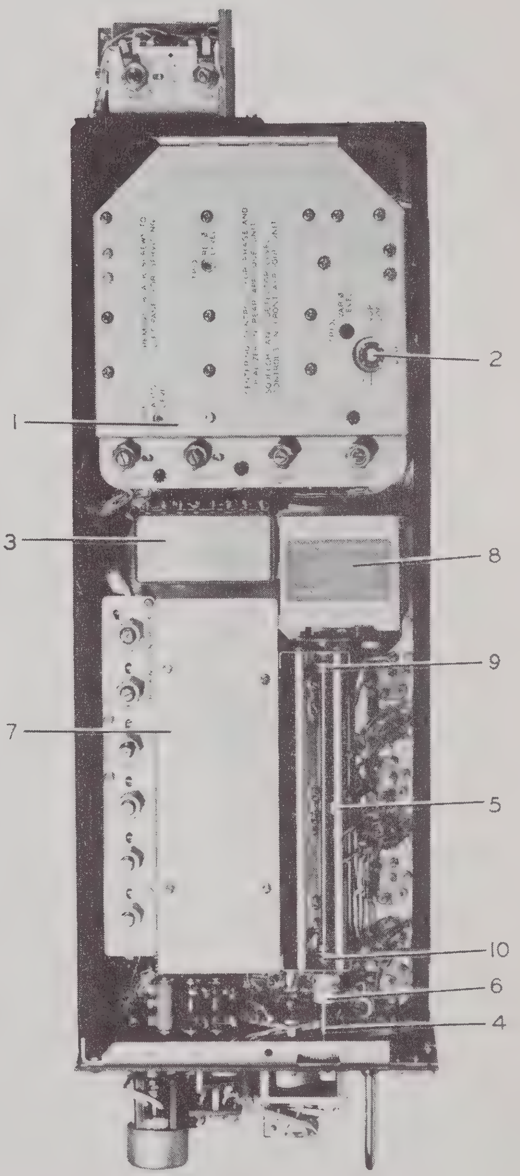
In the event the hinged control and capacitor mounting panel, (1) figure 9-1, must be removed proceed as follows:

a. Remove black screws and swing panel open.

b. Unsolder wiring at the component terminals.

c. Lay wiring back so as not to interfere with subsequent operations.

d. Remove three #6 screws located at three corners of the filter mounting plate. Remove hexagonal standoff at top corner of filter mounting plate adjacent to Z-106.



(1) Hinged Capacitor Mounting Plate
(2) K-105
(3) Z-104
(4) Fine Frequency Autopositioner Shaft
(5) Variable I-F Amplifier Tuner Frame Shaft
(6) Flexible Coupler
(7) R-F Subassembly
(8) Fine Frequency Oscillator
(9) (10) Oilite Bearings

Figure 9-1. Type 51R-3 Receiver, Wiring Side

e. Remove one binder head and two flat head screws accessible at rear of receiver. These screws secure the control and capacitor mounting panel hinge.

f. Replace hinged panel using either old components remounted or new components. Procedure is inverse to disassembly.

9-3. REMOVAL OF ROTARY RELAY K-105.

This relay, (2) figure 9-1, is mounted by means of four 4-40 flat head screws passing through the chassis. To gain access to these screw heads it will be necessary to first remove capacitor C-187 assembly. See paragraph 9-5 below for removal of C-187 assembly. If the reason for removal of rotary relay K-105 is a defective wafer or contract, follow the procedure in paragraph below. If the reason for removal is definitely not concerned with switch wafers, then proceed as follows:

a. Unsolder actuator coil leads from wafer terminals T7, T8, and T9.

b. Remove the two wafer mounting screws on top surface of top wafer and lift both wafers from actuator coil assembly. Dress clear of actuator coil assembly.

c. Remove four 4-40 flat head mounting screws accessible beneath C-187. Temporarily replace C-187 to prevent damage to connecting leads.

d. Replace actuator coil assembly (complete relay less wafers) and resolder new coil connections to wafer terminals T7, T8, and T9.

e. Energize the relay intermittently as the wafer mounting screws are tightened to insure no switch contact binding. Rotate and/or displace wafer laterally as required for minimum switch wafer friction. Relay K-105, if properly assembled, will close sharply on 20 volts dc. Source of dc must be low impedance as actuator coil draws 4.0 amperes for a fraction of a second.

f. Replace reassembled switch on chassis and remove and replace C-187 both in the inverse of disassembly.

9-4. ALTERNATE PROCEDURE FOR RELAY K-105.

a. While K-105 is still mounted to chassis, remove those connecting wires which are accessible, including R-238.

b. Remove four 4-40 flat head mounting screws accessible beneath C-187. Temporarily replace C-187 to prevent damage to connecting leads.

c. With K-105 removed from chassis, complete unsoldering of connections not removed in step a. above.

d. Reconnect those wires disconnected in c. above.

e. Remount K-105 on chassis.

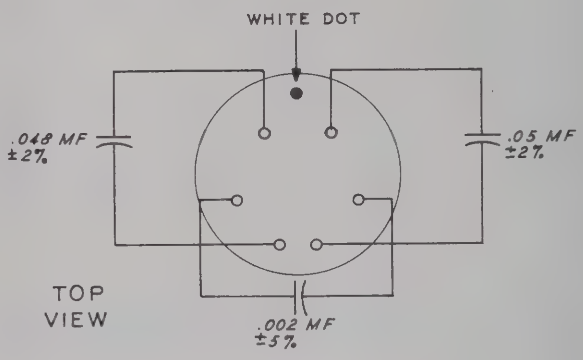


Figure 9-2. C-187 Simplified Schematic Diagram

9-5. DETERMINATION OF A DEFECTIVE C-187 ASSEMBLY.

Symptoms of a defective C-187 assembly, (10) figure 9-8, are a displaced accuracy curve several degrees from the proper zero bearing but which has the normal plus or minus variation.

a. Check C-187 by referring to figure 9-2 and making capacitance measurements.

b. Do not attempt repair work on C-187. Replace it as a unit. To remove C-187, unsolder the three wires connected to the assembly. Remove wires and components on two insulated standoffs which mount on the two top C-187 mounting screws. Then remove the standoffs. Remove the four 4-40 screws and associated lock washers holding the assembly to the chassis. Note that if C-187 is to be removed to gain access to the mounting screws for K-105, it is not necessary to unsolder the three connecting wires, but it is necessary to remove the two standoffs.

c. To replace C-187, follow step b. in inverse order. Use liquid staking compound on the two insulated standoffs of b. above.

9-6. DETERMINATION OF A DEFECTIVE Z-104 UNIT.

Symptoms of a defective Z-104 unit, (3) figure 9-1, usually appear as an extremely poor VOR error curve. See paragraph 6-11 for VOR Error Curve. To determine whether Z-104 is faulty as well as to determine which component in Z-104 is defective take measurements and compare with figure 9-3 and the table below.

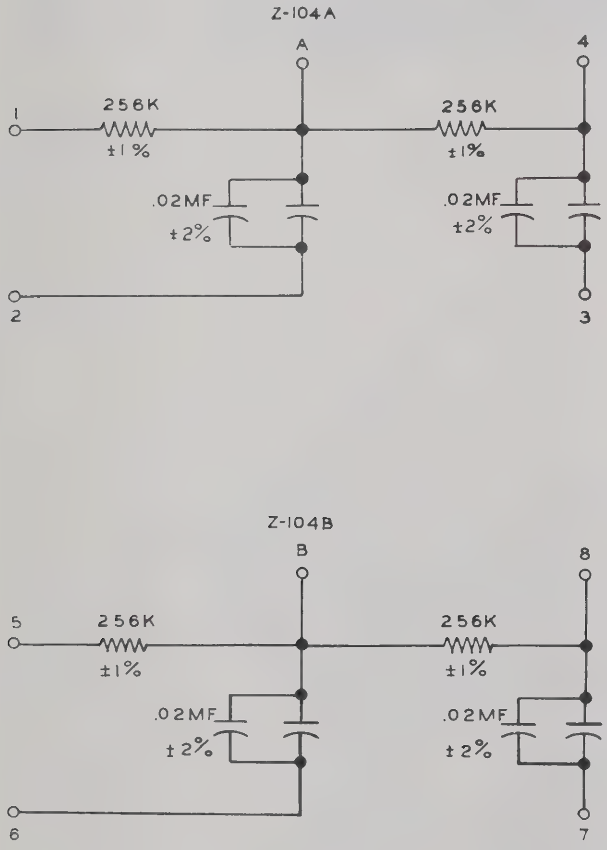


Figure 9-3. Z-104 Schematic Diagram

Terminal	R. Meas.	Terminal	C. Meas.
1-A	256K ± 1%	2-A	.02 uf ±2%
A-4	256K ± 1%	3-4	.02 uf ±2%
5-B	256K ± 1%	6-B	.02 uf ±2%
B-8	256K ± 1%	7-8	.02 uf ±2%

In making the preceding measurements, it is not necessary to unsolder wires connected to the terminals of Z-104. The receiver should not be connected to any external circuits (P-101 open circuited). To remove Z-104 it is necessary to remove the coarse frequency crystal box. See paragraph 9-7 below.

a. Unsolder the eight wires connected to the terminals. Note where each was connected for convenience in reconnection.

b. Remove the coarse frequency crystal box.

c. Remove the four screws securing Z-104 (on tube side).

d. Lift Z-104 assembly out of chassis and replace with a new unit.

e. Reassemble in reverse order of disassembly.

9-7. REMOVAL OF COARSE FREQUENCY CRYSTAL BOX.

a. Remove the three #6 hexagonal nuts and external tooth lock washers which secure the coarse frequency crystal box to the coarse frequency tuner frame.

b. Move the coarse frequency crystal box 1/2" to the rear and lift out.

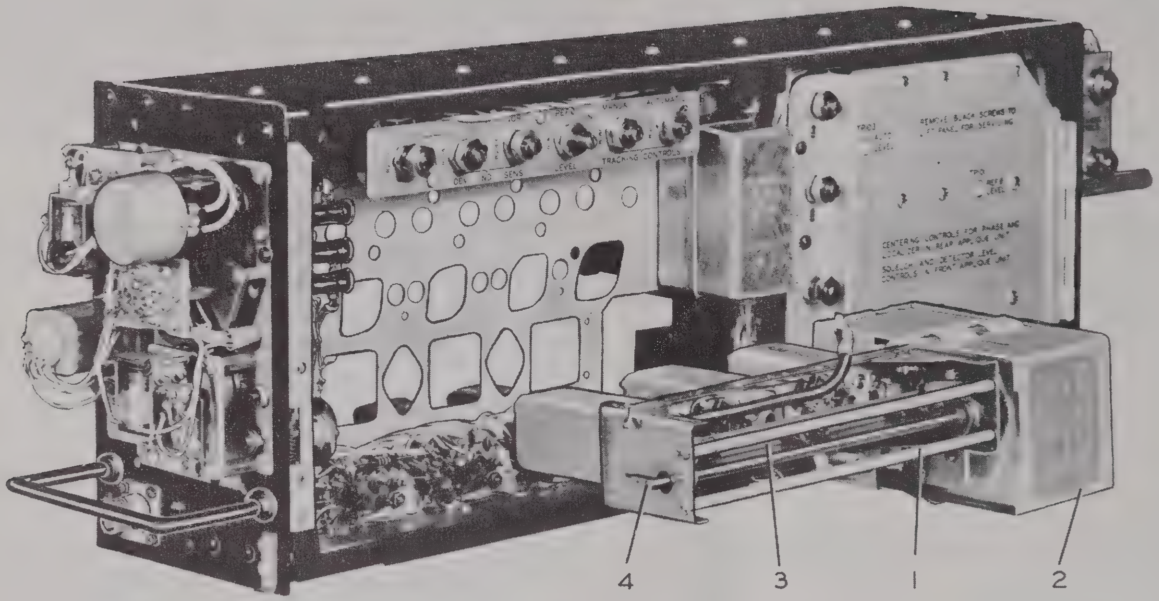
CAUTION

Use great care not to change the position of switch S-106 rotor.

9-8. REMOVAL OF VARIABLE I-F AMPLIFIER AND FINE FREQUENCY OSCILLATOR.

In the event of a failure in the variable i-f amplifier, (1) figure 9-4, or fine frequency oscillator, (2) figure 9-4, necessitating removal of one or both of the units, it will be, in most cases, advisable to remove the two units together as one unit. If this is done it will be unnecessary to disturb the mechanical synchronization established between the two units.

a. Set the fine frequency Autopositioner shaft, (4) figure 9-1, as required to loosen the four



(1) Variable I-F Amplifier
(2) Fine Frequency Oscillator
(3) Slug Table
(4) Tuner Frame Shaft

Figure 9-4. Removal of Variable I-F Amplifier and Fine Frequency Oscillator

set screws securing the flexible coupler, (6) figure 9-1, to the variable i-f amplifier tuner frame shaft, (5) figure 9-1, and the Autopositioner shaft.

b. Slide the flexible coupler forward on the shaft, toward the front panel, until the end of the tuner frame shaft is exposed.

c. Remove the cover from the r-f subassembly, (7) figure 9-1, and unsolder length of coaxial cable that leads into the assembly above tube socket XV-102. This coaxial lead connects by its inner conductor to a standoff located adjacent to tube socket XV-102 and by its outer conductor to the partition directly above tube socket XV-102. Back this end of the coaxial lead through the grommeted hole in the side of the r-f subassembly and dress clear of the r-f subassembly.

d. Unsolder the black-white wire attached to feed thru capacitors and running to pin 3 of V-104 and running to pin 4 of V-105.

e. Unsolder the 100,000 ohm, R-112, and the 3300 ohm, R-114, resistors that extend over the side of the tuner frame to standoffs located on the main chassis in the fixed i-f amplifier strip. Unsolder at the standoffs.

f. Unsolder length of #20 bus wire attached to the standoff adjacent to V-104 tube socket, at the standoff.

g. Unsolder the 100,000 ohm, R-116, resistor that extends over the side of the tuner frame to the standoff located on the main chassis near XV-105. Unsolder at the standoff.

h. Unsolder the blue-white wire attached to pin 1 of T-105, at pin 1.

i. Unsolder the green-white wires from the standoff on the mounting stud of T-103 and the feed-thru capacitor adjacent to T-103. Dress all leads clear of tuner frame.

j. Remove the two #4 binder head screws and associated nuts, located at the extreme front corners of the tuner frame. These screws are accessible from the tube side of the main chassis and are adjacent to T-103.

k. Remove one #4 binder head screw from the lower rear of the tuner frame. This screw is accessible from the wiring side of the chassis and its associated nut is located adjacent to T-110 on the tube side of the main chassis.

l. Remove one #4 binder head screw located adjacent to T-110 and accessible from the tube side of the chassis.

m. Remove tube hold-down shields from V-103 and V-104.

n. Place wiring side of receiver up or set receiver upright and withdraw tuner frame and attached fine frequency oscillator housing as far as the two remaining attached wires will permit. Unsolder the red-blue-white and black-white wires that pass through the chassis and connect to TB-101 on the oscillator housing.

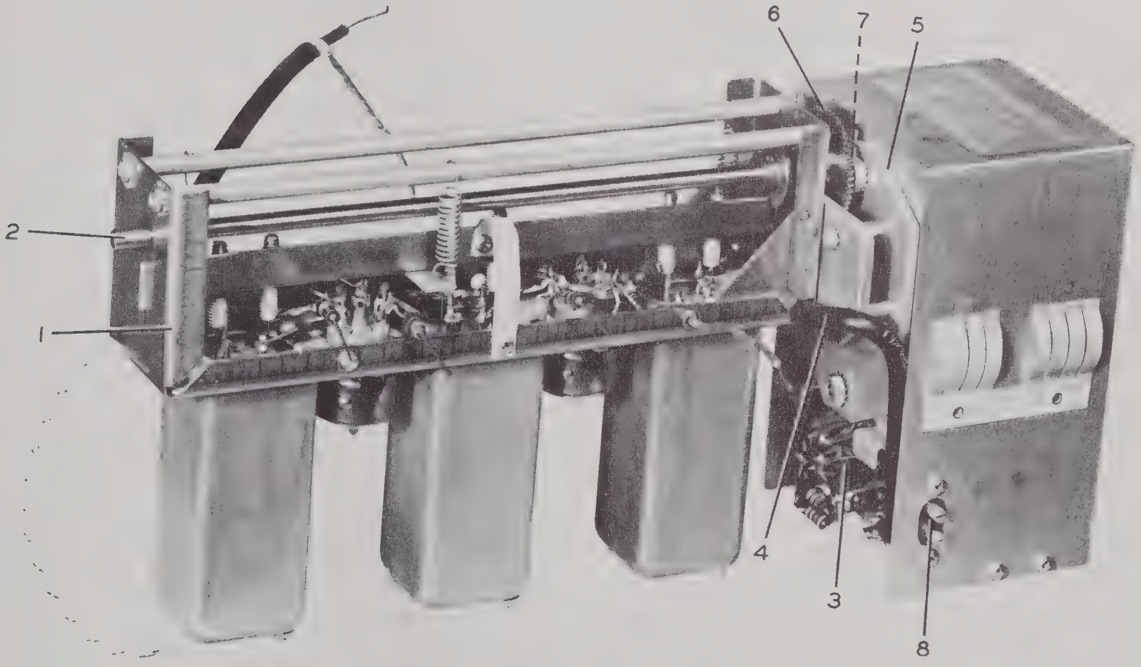
o. To replace the tuner frame and fine frequency oscillator housing it will be necessary to follow the above steps in the reverse order.

p. When replacing the variable i-f amplifier and fine frequency oscillator it will be necessary to re-establish the mechanical synchronization between the tuner frame shaft and the fine frequency autopositioner shaft as outlined in paragraph 9-13.

9-9. REMOVING FINE FREQUENCY OSCILLATOR FROM VARIABLE I-F AMPLIFIER.

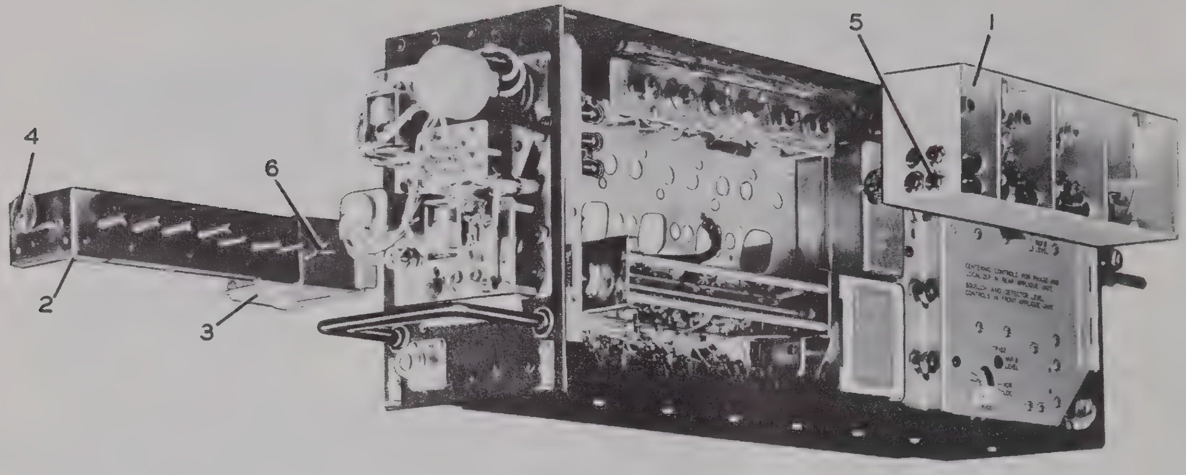
To remove the fine frequency oscillator housing from the variable i-f amplifier follow the procedure below:

a. Remove the oscillator housing cover nearest the front of the receiver. This will expose the length of coaxial lead, (4) figure 9-5, connecting the two units together. Unsolder the inner conductor of this coaxial lead from pin 5 of tube socket XV-113. Dress this inner conductor clear of the socket and unsolder the outer conductor



(1) Variable I-F Tuner Frame
(2) Tuner Frame Shaft
(3) Fine Frequency Oscillator
(4) Coaxial Lead
(5) Eight Sided Bearing Plate
(6) Gear
(7) Oilite Bearings
(8) TB-101

Figure 9-5. Variable I-F Amplifier and Fine Frequency Oscillator



(1) R-F Subassembly
(2) Coarse Frequency Tuner Frame
(3) Coarse Frequency Crystal Box
(4) Coupler
(5) Feedthru capacitors
(6) Two wires

Figure 9-6. Removal of R-F Subassembly

from the ground terminal using care not to overheat the coaxial cable. Dress the coaxial lead clear of the oscillator housing.

b. Using a 5/16 inch end wrench, remove the two #6 hexagonal nuts that hold the fine frequency oscillator housing to the eight sided bearing plate, (5) figure 9-5.

c. Withdraw the oscillator housing from the eight-sided bearing plate.

d. To reassemble the oscillator housing and the tuner frame follow the above steps in the reverse order using great care in step b. to insure that the crystal switch in the oscillator housing runs free with the rotation of the tuner frame shaft before tightening the two #6 hexagonal nuts.

e. When reassembling the fine frequency oscillator and the variable i-f amplifier it will be necessary to re-establish the mechanical synchronization between the fine frequency oscillator crystal selector switch and the tuner frame shaft as outlined in paragraph 9-13.

9-10. REMOVAL OF R-F SUBASSEMBLY.

To remove the r-f subassembly from the receiver follow the procedure below:

a. Unsolder the six wires, from the front of the r-f subassembly that attach to the feedthru capacitors, (5) figure 9-6. Unsolder the wire from the feed-thru capacitor adjacent to the variable i-f tuner.

b. Remove cover from the r-f subassembly and unsolder length of coaxial cable that leads into the assembly above tube socket XV-102. This coaxial lead connects by its inner conductor to the standoff located adjacent to tube socket XV-102 and by its outer conductor to the partition directly above XV-102. Back this end of the coaxial lead through the grommeted hole in the side of the r-f subassembly and dress clear of the r-f subassembly.

c. Unsolder the two wires, (6) figure 9-6, leading out the grommeted hole in the rear of the r-f subassembly. These wires run through the chassis to the coarse frequency oscillator crystal box.

d. Remove the four screws holding the six potentiometer panel and dress this panel clear of the r-f subassembly.

e. Expose the tube side of the receiver. Set the coarse frequency Autopositioner to the 108 mc position. Remove the eight small #4 hexagonal nuts located along the inside of the coarse frequency tuner frame, (2) figure 9-6. Use a 3/16 inch socket wrench to accomplish this.

f. Remove the two 4-40 screws (accessible from the tube side) that hold the r-f assembly to the main chassis.

g. Remove the r-f subassembly from the receiver. See figure 9-6.

CAUTION

Use great care not to damage either the slugs or the coil forms that surround them.

h. To replace the r-f subassembly, follow the above steps in the reverse order.

i. Realign the r-f subassembly, first mixer and coarse frequency oscillator as detailed in paragraph 6-9, Section VI, Alignment and Testing.

9-11. REMOVAL OF COARSE FREQUENCY TUNER FRAME AND CRYSTAL BOX.

To remove the coarse frequency tuner frame, (2) figure 9-6, and crystal box, (3) figure 9-6, from the receiver follow the procedure below:

a. Remove the cover from the r-f subassembly and remove the slugs from the coarse frequency slug table, (8) figure 9-8. This is accomplished by screwing the slug studs into the table until they drop through the coils.

b. Unsolder the two wires, (6) figure 9-6, leading out of the grommeted hole in the rear of the r-f assembly. These wires run through the chassis to the coarse frequency oscillator crystal box.

c. Expose the tube side of the receiver and set the coarse frequency Autopositioner to the 108.0 mc position.

d. Using a 3/16 inch socket wrench remove the eight #4 hexagonal nuts located along the inside of the coarse frequency tuner frame.

e. The coarse frequency tuner frame and attached crystal box may now be moved to the rear 1/8 inch and lifted from the receiver.

f. To reassemble follow the above steps in the reverse order.

g. During reassembly of the coarse frequency tuner frame and attached crystal box it will be necessary to re-establish the mechanical synchronization as outlined in paragraph 4-33.

9-12. REMOVAL OF RECEIVER HOUSING.

To remove the receiver housing follow the procedure below:

a. Remove the dust cover from the localizer filter unit on the rear of the receiver. Cover is secured with two 6-32 screws.

b. Unsolder, at the localizer filter unit, the ten wires that connect it to the receiver through the rear of the receiver housing.

c. Remove the localizer filter unit by removing its three 6-32 securing screws and hexagonal standoff.

d. Remove the four 6-32 screws that hold the rear plug, P-101, to the receiver housing.

e. Remove the seventeen 4-40 screws that hold the receiver housing to the main chassis. These are located along the center of the top and bottom of the receiver.

f. Remove one 4-40 screw above the rear plug.

g. Remove the eight 4-40 flat head screws that hold the receiver housing to the front panel. These are located along the sides of the front panel.

h. Place the receiver with the front dust cover face down on the bench and spring the receiver housing out away from the chassis just enough to lift it up over the rear of the receiver.

i. To replace, follow the above steps in the reverse order. Consult the practical wiring diagram, figure 12-2, to determine the proper position of each of the ten wires that must be resoldered to the localizer filter unit.

9-13. SYNCHRONIZATION OF VARIABLE I-F AMPLIFIER WITH FINE FREQUENCY AUTOPOSITIONER.

CAUTION

> The Autopositioner crank should be inserted and turned only with the receiver power switch off. It should be removed before the receiver is switched on. Should the Autopositioner cycle with the crank in position, it would revolve at high speed and if kicked out may cause injury to the operator.

a. Set the frequency of the receiver to an even megacycle position (110.0, 112.0) so that the indexing plate of the fine frequency autopositioner, figure 12-43, indicated 0.0 mc. In this position the slug table edge should be resting at the minimum cam radius point (slug table nearest to the tuner shaft).

b. Should the edge of the slug table not rest at the minimum cam radius point, loosen the two set screws in the front hub of the flexible coupler, (6) figure 9-1, and rotate the tuner shaft until the table is seated at the minimum cam radius point. Tighten both set screws.

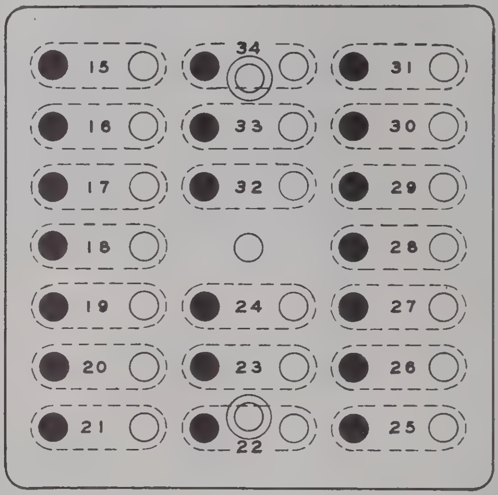
c. Set the frequency of the receiver one channel (100 kc) below the frequency selected in step a. (109.9, 111.9) so that the indexing plate on the fine frequency Autopositioner indicates 1.9 mc. In this position the edge of the slug table should be resting near the point of maximum cam radius. Check for full contact between the cams and the edge of the slug table.

d. Should the edge of the slug table extend over the drop off section of the cam repeat steps a, b, and c.

9-14. SYNCHRONIZATION OF FINE FREQUENCY CRYSTAL SELECTOR SWITCH WITH FINE FREQUENCY AUTOPOSITIONER.

a. Set the frequency of the receiver to an even megacycle position (110.0, 112.0) so that the indexing plate of the fine frequency Autopositioner indicates 0.0 mc.

b. Connect an ohmmeter from the ungrounded socket pin of crystal position 15 and the grid of V-113, pin 1. (See figure 9-7) If the ohmmeter indicates a closed circuit, proceed with step g. If the ohmmeter indicates an open circuit, continue with step c.



SHADED PINS INDICATE UNGROUNDED SIDE OF CRYSTALS

Figure 9-7. Fine Frequency Oscillator Crystal Positions

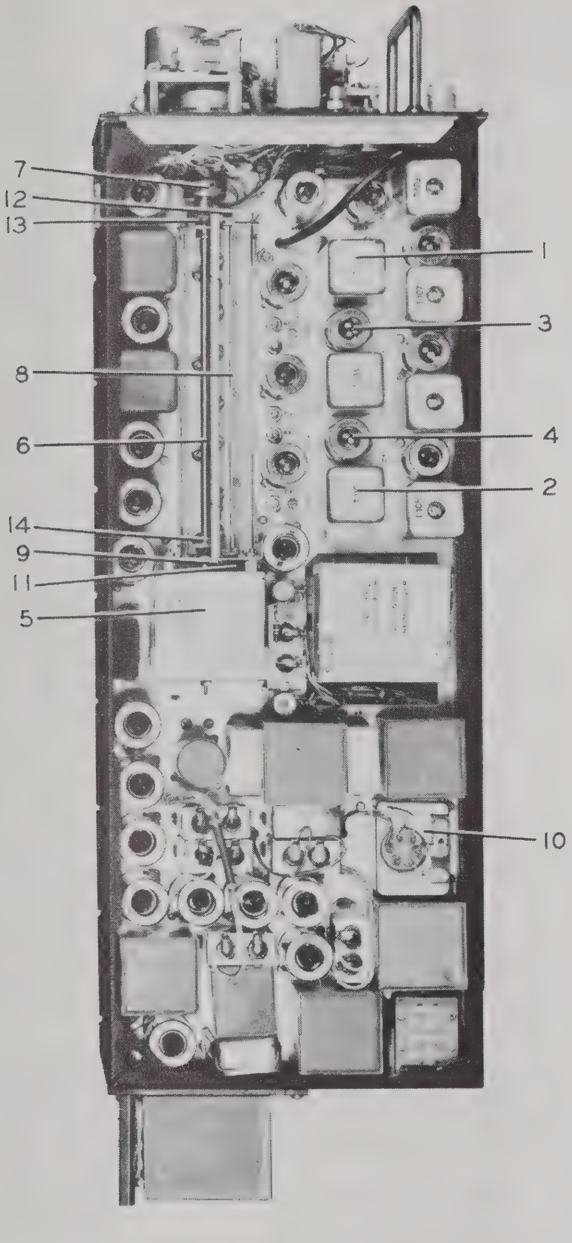
c. Loosen the exposed set screw in the gear, (6) figure 9-5, mounted on the end of the variable i-f tuner shaft nearest the fine frequency oscillator.

d. Using a Bristo wrench as a lever, rotate this gear clockwise or counterclockwise as required to close the circuit from V-113, pin 1, to crystal socket position 15.

e. Rotate the gear clockwise and counterclockwise and note the two positions of the wrench at which the circuit opens.

f. Rotate the gear to a point midway between the two points of open circuit, and tighten the set screw.

g. To determine if the switch arm is centrally located on the switch contact, insert Autopositioner crank (receiver switch off), close the fine frequency Autopositioner relay manually to lift the pawl from the stop wheel slot, and then turn the crank clockwise. Properly synchronized, the crystal selector switch should open between 5 and 6 turns of the crank.



(1) T-103
(2) T-110
(3) V-103
(4) V-104
(5) Coarse Frequency Crystal Box
(6) Coarse Frequency Tuner Shaft
(7) Coarse Frequency Shaft Coupler
(8) Slug Table
(9) Switch Coupler
(10) C-187 Assembly
(11) (12) Oil Retainer Washers
(13) (14) Oilite Bearings

Figure 9-8. Type 51R-3 Receiver, Tube Side

h. Should the selector switch not open after 5 or 6 turns of the crank, remove the crank from the receiver, turn receiver power on, turn frequency selector to a lower frequency and back to the frequency selected in step a. This resets the fine frequency Autopositioner pawl in the 0.0 mc slot.

i. Switch the receiver off, close the fine frequency Autopositioner relay armature, manually to lift the pawl from the stop wheel slot, insert the crank and turn clockwise 5-1/2 turns.

j. Loosen the set screw in the gear on the tuner shaft and turn the gear counterclockwise from a closed circuit position until the circuit breaks. Tighten set screw.

k. Repeat step g. to check contact centering.

9-15. SYNCHRONIZATION OF COARSE FREQUENCY TUNER WITH COARSE FREQUENCY AUTOPOSITIONER.

The coarse frequency tuner shaft, (6) figure 9-8, has the coarse frequency coupler shaft, (7) figure 9-8, and cams pinned in position. Design of the flexible coupler allows coupling of the Autopositioner shaft to the coarse frequency tuner shaft in two possible positions with respect to each other. To engage the coupler at the proper position, set the Autopositioner to 134. mc and the slug table, (8) figure 9-8, to the lowest point on the cam, (turn tuner shaft until the slug table is at the point nearest the shaft) and engage the coupler.

9-16. SYNCHRONIZATION OF COARSE FREQUENCY CRYSTAL SELECTOR WITH COARSE FREQUENCY AUTOPOSITIONER.

CAUTION

The Autopositioner crank should be inserted and turned only with the receiver power switch off. It should be removed before the receiver is switched on. Should the Autopositioner cycle with the crank in position, it would revolve at high speed and if kicked out may cause injury to the operator.

a. Set the Autopositioner to 134. megacycles.

b. Connect ohmmeter across crystal 14 socket terminals. With capacitor C-105 shorted, the ohmmeter should indicate a closed circuit, indicating the selector switch is at or near proper synchronization with the Autopositioner. If circuit is closed, omit steps c, d, e, and proceed with step f. If circuit is open proceed with step c.

NOTE

> Capacitor C-105 is not included in receivers bearing serial numbers 173 and below, with exception of serial numbers 9, 18, 41, and 45.

c. Should the ohmmeter show an open circuit across crystal 14 contact, loosen the two set screws in the switch coupler, (9) figure 9-8, accessible in this position. Using a Bristo wrench as a lever, turn the coupler clockwise or counterclockwise until the ohmmeter indicates a closed circuit.

d. With the coupler in position above and the ohmmeter indicating a closed circuit, turn the coupler with the Bristo wrench first clockwise, then counterclockwise, and note the position of the wrench in each case when the circuit opens.

e. Rotate the coupler with the Bristo wrench to a point midway between the two open circuit positions and tighten one set screw. This step locates the switch arm approximately in the center of the switch contact.

f. To determine if the switch arm is centrally located on the switch contact, insert the Autopositioner crank (receiver switched off) and close the coarse frequency Autopositioner relay manually to lift the pawl from the stop wheel slot. Turn the crank clockwise until the ohmmeter shows open circuit. With the selector switch properly synchronized, the ohmmeter across crystal #14 contacts will show an open circuit after 5 to 6 turns of the crank.

g. Should the ohmmeter not show an open circuit between 5 and 6 turns of the crank, remove crank from receiver, turn receiver on and turn receiver frequency selector to a lower frequency, then back to 134 mc. This resets the Autopositioner pawl in the 134 mc slot.

h. Turn receiver off and close the coarse frequency Autopositioner relay armature to lift the pawl from the stop wheel slot. Insert the crank and turn clockwise 5-1/2 turns.

i. Loosen set screw tightened in step e. above and rotate switch coupler in a counterclockwise direction from a closed circuit position until the circuit just opens. Tighten set screw.

j. Repeat step f. to check contact centering.

k. Tighten coupler set screws.

l. Remove the short from C-105.

AUTOPOSITIONER REPAIR AND ADJUSTMENT.

9-17. OPERATING AUTOPOSITIONER WITHOUT CONTROL UNIT.

To operate the Autopositioner without a control unit, press the armature (6), (7) figure 9-9, on the Autopositioner to step the mechanism around to the desired position. The index plates,(4), (5) figure 9-9, on the Autopositioner indicate the frequency. The sum of the readings on the two Autopositioners gives the frequency to which the receiver is tuned. With relay K-103 in its normal position (not energized) stepping the Autopositioners around by pressing the relay armatures, selects only even frequencies, i.e., 108 mc, 110 mc, 112 mc, etc.

9-18. AUTOPOSITIONER MOTOR REPAIR.

The motor, (11) figure 9-9, is mounted on the front panel with the commutator end farthest away from the panel. The brushes are covered by an end bell that fits over the protruding end of the motor.

9-19. REPLACEMENT OF AUTOPOSITIONER MOTOR BRUSHES.

When brushes are worn to less than one-fourth inch in length they should be replaced with new brushes in the following manner:

a. Remove end bell.

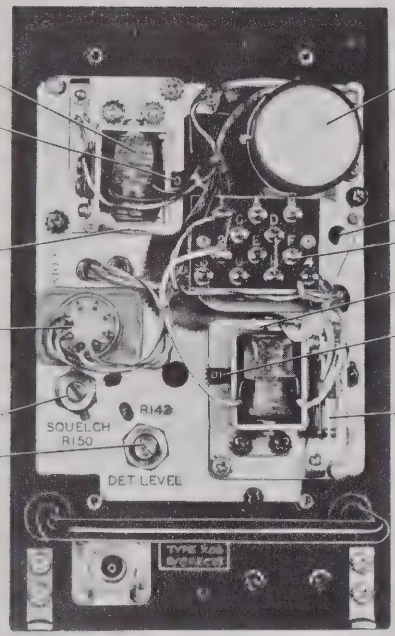
b. Unsolder leads to brushes.

c. Lift the spring off of the brushes and remove the brushes from the holders.

d. Replace with new brushes and reverse the procedures given in steps a., b., and c. above.

9-20. REPLACEMENT OF AUTOPOSITIONER MOTOR.

The only maintenance to be undertaken on the Autopositioner motor is replacement of the motor brushes. All other troubles generally require replacement of the motor as follows:



(1) Autopositioner Crank Insertion Point
(2) Fine Frequency Autopositioner
(3) Coarse Frequency Autopositioner
(4) Coarse Frequency Autopositioner Index Plate
(5) Fine Frequency Autopositioner Index Plate
(6) Fine Frequency Autopositioner Armature
(7) Coarse Frequency Autopositioner Armature
(9) Squelch Control, R-150
(10) Relay, K-103
(11) Autopositioner Motor
(12) DET LEVEL R-142
(13) Patch Panel

Figure 9-9. Type 51R-3 Receiver Front Panel

a. Unsolder the power leads from the motor at panel terminals.

b. Remove four 4-40 screws holding mounting plate and motor to front panel.

c. Remove four 2-64 screws holding motor mounting plate to motor.

d. Assemble and mount new motor in reverse order.

9-21. AUTOPOSITIONER SOLENOID ADJUSTMENT.

When it becomes necessary to readjust an Autopositioner solenoid without removing it from a unit, proceed as follows:

a. Loosen solenoid mounting screws.

b. With pawl engaged in one of the notches of the stop-wheel, hold the pawl fully seated in the notch.

c. Rotate the solenoid clockwise about the mounting screws so that the frame and armature contacts the pawl projection to eliminate all lost motion in the solenoid.

d. Tighten solenoid mounting screws in this position.

e. Depress the solenoid armature and check to see that the pawl lifts clear of the notch to allow free rotation of the stop-wheel. Pawl should clear the stop-wheel teeth by about 1/64 of an inch. More than 1/32 of an inch clearance indicates excessive solenoid travel with a corresponding loss of power. Solenoid travel can be adjusted, if necessary, by loosening the two screws near the hinge and sliding the hinge plate up or down slightly as required.

f. The motor-operating contacts on the solenoid should be adjusted to maintain contact when the pawl is resting on top of a stop-wheel tooth between positions with the solenoid de-energized. This is to insure that the motor will continue to drive until the pawl engages the proper notch, which opens the contacts by at least .025". Contacts can be adjusted, if necessary, by bending the stationary contact arm.

9-22. AUTOPOSITIONER SOLENOID REPLACEMENT AND ADJUSTMENT.

If for any reason it is necessary to replace an Autopositioner solenoid and align it, the following procedure should be used.

a. Seat the pawl in a notch of the stop-wheel. Turn the gear train by hand to allow the pawl to seat fully.

b. Place the solenoid so that the pawl finger comes between the solenoid spring and frame at about the middle of the spring.

c. Line up the mounting hole farthest from the pawl and start this mounting screw, without applying any pull to the solenoid spring. That is, let the solenoid turn clockwise slightly.

d. Turn the solenoid counterclockwise about this screw. This will let the pawl finger slide between the spring and solenoid arm. Start the second screw.

e. Hold the pawl fully seated in the stop-wheel notch and hold the solenoid frame against the pawl finger. Tighten mounting screws. See that the pawl is fully seated and that the solenoid armature and arm have no appreciable free play. Reposition if necessary to meet these conditions.

f. Depress the solenoid armature and turn the Autopositioner manually or under power and check the clearance between the pawl tip and the stop-wheel. This should be approximately 1/64" or less. If adjustment is required, loosen the two screws near the hinge point and slide the hinge plate up or down as required. Adjustment may be aided by placing a .020" feeler gauge between the armature and coil core. Be careful that the solenoid arm does not rub on the side of the frame or against the stop-wheel and that the spring does not shift closer to the contacts when tightening these screws.

g. Check the operation of the motor contacts. With power off, depress armature of the solenoid and turn the gearing to let the pawl tip rest on the stop-wheel between notches. In this position the motor-operating contacts should be closed and the armature and arm should have a small amount of free play to permit full contact pressure at the contact points.

h. If necessary, bend the stationary contacts in or out. Failure to make contact in this position may allow the Autopositioner to set up at the wrong position with the seeking switch circuit open, but with the pawl between notches. Excessive free play of the armature in this position indicates insufficient contact opening in the de-energized position.

9-23. REMOVAL OF AUTOPOSITIONER UNITS.

CAUTION

Use care in removal and replacement of Autopositioner so as not to damage switch wafers driven by Autopositioner.

a. To remove the megacycle Autopositioner loosen the coupler (end of coupler nearest switch) that couples the Autopositioner to the tuner frame shaft. Loosen the mounting screws that hold the Autopositioner to the front panel and lift the mechanism from receiver.

b. To remove the tenth megacycle, Autopositioner loosen the coupler and loosen the set screw in the gear behind the panel. Then loosen the screws that secure the Autopositioner to the front panel and lift the mechanism from the panel.

9-24. AUTOPOSITIONER CLUTCH MAINTENANCE.

a. To gain access to the clutch, remove Truarc retaining ring using Truarc pliers and slide the gear off of the shaft.

b. To remove the clutch from the drum, press the ends of the clutch toward each other, using wire bending pliers, and slide the clutch out of the drum.

c. To remove the clutch drum from the shaft, remove the Truarc ring with Truarc pliers and while holding the shaft, (do not use pawl to hold the shaft) loosen the nut with the pliers or a wrench and proceed to slip the spacer and drum from the shaft.

CAUTION

Do not use pawl to hold the shaft. Doing so may bend pawl or shear pawl pivot pin.

d. Before replacing the clutch ring in the drum, carefully wipe the inside of the drum to remove oil and grease. Inspect the drum surface for scoring.

e. Lubricate the oilite bearing in the mounting plate with a drop of AN-O-4 oil.

f. The resilience and number of metal springs within the clutch shoe determines the torque of the clutch. Each Autopositioner should have 6-1/2 to 7 inch-pounds of torque in order to function properly.

CAUTION

> Caution must be exercised in reassembly of the clutch drum to the shaft to insure that the retaining nut is tightened sufficiently to insure against slippage.

g. To reset the index plate after having loosened or removed the clutch drum, assemble the Autopositioner up to the point of tightening the nut that secures the clutch drum and index plate. Rotate the shaft until the flat on the shaft is opposite the notch in the mounting plate. Rotate the index plate until the plate indicates "112" if working on the megacycle Autopositioner or "0.6" if working on the tenth megacycle Autopositioner and tighten the nut with 70 inch-pounds of torque holding shaft with flats on shaft.

CAUTION

> Do not use pawl to hold the shaft. Doing so may bend pawl or shear pawl pivot pin.

h. Reassemble the Autopositioner and make adjustments of relays as outlined in paragraphs 4-48 and 4-49.

9-25. SYNCHRONIZATION OF AUTOPOSITIONER SWITCHES.

Synchronization of the Autopositioner switches can be made by visual inspection. Alignment is not critical, but the switches should be positioned so that the blade segments are well centered on the switch positions. The unit should be run under power and each switch stack checked at several positions to eliminate any errors caused by backlash and eccentricity.

9-26. OVERHAUL PROCEDURE.

a. Disassemble the unit and discard the old bearings and brushes.

CAUTION

> To prevent damage to armature shaft and commutator ends use the proper tools in removing the old bearings.

b. Preliminary cleaning of dust and other loose dirt from the components may be done with compressed air and/or a soft brush.

c. Check all windings and commutator segments for shorts and open windings. Be sure the voltage used for these tests is not high enough to damage the insulation on the armature winding wire.

d. Check the armature shaft for mechanical straightness.

CAUTION

> All further steps in the overhaul and buildup procedure should be done in a dust and dirt free area under reasonable humidity conditions.

e. New bearings should be degreased by washing in varasol. This should preferrably be accomplished by agitating the bearing in varasol. Use of stiff brushes can harm bearing surfaces and races. Also, use of high pressure air streams to clean the bearing and races can be detrimental due to possible high speeds set up with the bearing unlubricated.

f. Thoroughly clean the armature and shaft, and check bearing areas on the shaft for wear.

g. Grease the new bearings with "ANDOC C" grease, using the fingers only. Do not use stiff brushes, or wooden or metal paddles. Wipe off the excess grease.

h. Seat the bearings on the shaft with the shielded side inward (toward the commutator), using a proper press tool, one that places pressure on the inner race only, and in no way exerts force on, or distorts the outer race.

i. Set the armature up in a lathe, using the new bearing centers, to belt drive the armature from its center portion.

(1) Solenoid, K-101, K-102

(2) Shaft assembly

(3) Pawl

(4) Pawl pivot pin

(5) Dial

(6) Clutch drum

(7) Flange

(8) Retainer ring

(9) Friction clutch

(10) Springs

(11) Gear

(12) Motor, B-101

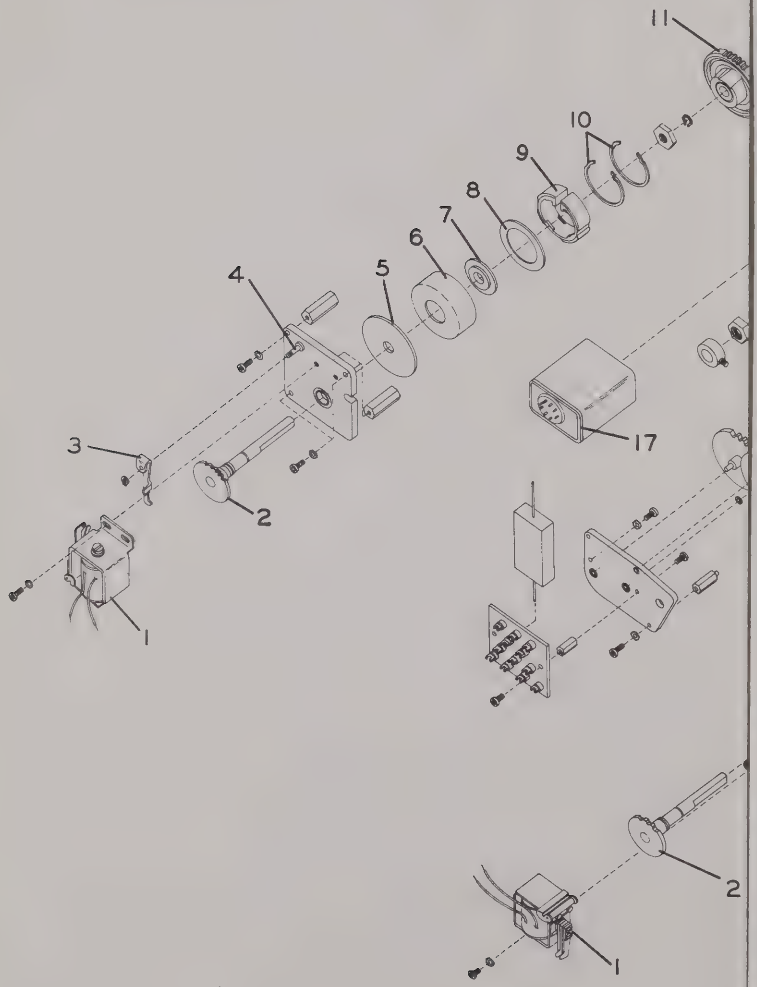
(13) Sleeve bearing

(14) Reduction gears

(15) Gear

(16) Flexible coupling

(17) Relay, K-103



j. Four circular discs of approximately twice the diameter of the bearings should be made from thin sheet fiber material. Holes, equal to the armature shaft size made in each disc center, then slots, the width of the center hole cut to their perimeter. Slide two of these discs in opposite direction over the shaft between the commutator end and the bearing to prevent metal chips and filings from entering the bearings.

k. If needed, both commutators should be turned down and polished. Care should be taken to keep the cut, in turning down a commutator, light enough that no undue strain is placed on the bearings. Turning down of commutators should be very limited particularly of the 1/16 in. at the extreme inner end of the commutator segments to prevent damage of the armature winding wires where they connect to the commutator segment bars.

l. Undercutting should then be done. Clean all metal chips and particles from the unit using care to prevent foreign material from entering the bearings. Caution is also advised when undercutting to prevent severing or otherwise damaging the armature winding wires where connections are made to the commutator segments. These connections are made at the inner end of the segment bar and usually on the side of each bar. As these segment bars are of necessity not very thick in dynamotors of this size, damage can easily result from undercutting to excess at the inner ends of the segment bars.

m. The armature should again be thoroughly tested and inspected for shorts and open windings, using the same precautions as in C above.

n. After thorough cleaning of all housing, bell ends, etc., the unit should be reassembled with new brushes on the proper (low voltage and high voltage) ends.

o. End play in the armature shaft should be adjusted by shimming to between .004 and .007 inches clearance.

p. After visual inspection and ascertaining that the armature is free to rotate, the unit should be reassembled on the power unit and "run-in" for 8 hours with no load.

q. After the "run-in", make visual and final inspection for mechanical noise. Input and output voltages and current values should be verified before returning the unit to service.

9-27. 314U-8, 10 and 614F-2 WIRING.

In these units, the switch pies are positioned with the "X" on top and facing forward. The pies are numbered from the panel progressing alphabetically toward the rear with the "A" pie of lowest number next to the panel. In the 314U-8 unit, pie S451B remains on the assembly even though it may not be used.

2-28. PILOT LAMPS OF CONTROL UNITS

Unit	Lamp E and I	Type	Collins P/N
314U-1	3v, 0.19A	GE323	262 0064 00
314U-2	3v, 0.19A	GE323	262 0064 00
314U-5	3v, 0.19A	GE323	262 0064 00
314U-8	28v, 0.04A	GE Mazda 327	262 0179 00
314U-10	28v, 0.04A	GE Mazda 327	262 0179 00
614F-2	28v, 0.04A	GE Mazda 327	262 0179 00

(1) Solenoid, K-101, K-102
(2) Shaft assembly
(3) Pawl
(4) Pawl pivot pin
(5) Dial
(6) Clutch drum
(7) Flange
(8) Retainer ring
(9) Friction clutch
(10) Springs
(11) Gear
(12) Motor, B-101
(13) Sleeve bearing
(14) Reduction gears
(15) Gear
(16) Flexible coupling
(17) Relay, K-103

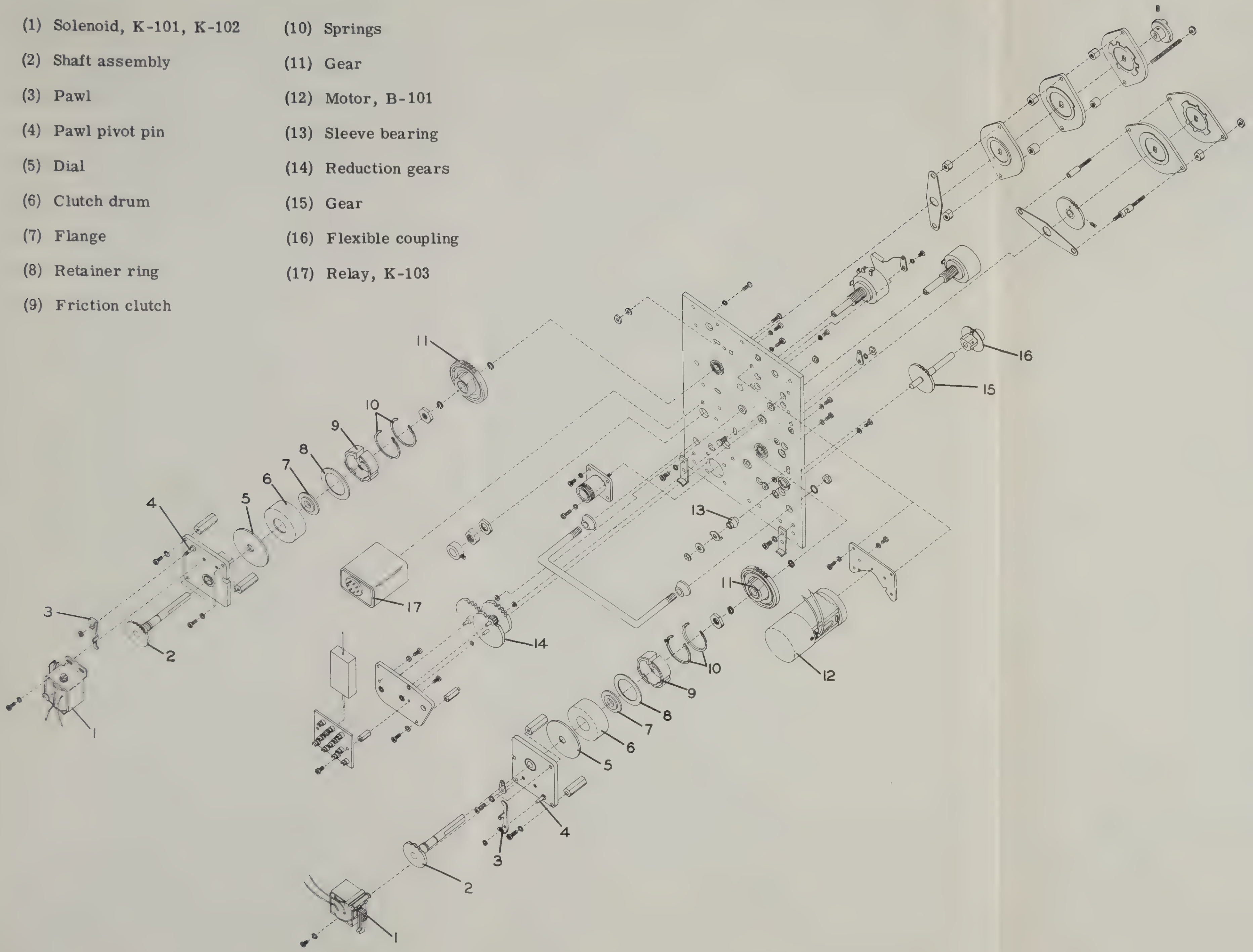

11
10
9
8
7
6
5
4
3
2
1
16
15
13
17
14
11
10
9
8
7
6
5
12
4
3
2
1

Figure 9-10. Exploded View of Front Panel Showing Autopositioner

j. Four circular discs of approximately twice the diameter of the bearings should be made from thin sheet fiber material. Holes, equal to the armature shaft size made in each disc center, then slots, the width of the center hole cut to their perimeter. Slide two of these discs in opposite direction over the shaft between the commutator end and the bearing to prevent metal chips and filings from entering the bearings.

k. If needed, both commutators should be turned down and polished. Care should be taken to keep the cut, in turning down a commutator, light enough that no undue strain is placed on the bearings. Turning down of commutators should be very limited particularly of the 1/16 in. at the extreme inner end of the commutator segments to prevent damage of the armature winding wires where they connect to the commutator segment bars.

l. Undercutting should then be done. Clean all metal chips and particles from the unit using care to prevent foreign material from entering the bearings. Caution is also advised when undercutting to prevent severing or otherwise damaging the armature winding wires where connections are made to the commutator segments. These connections are made at the inner end of the segment bar and usually on the side of each bar. As these segment bars are of necessity not very thick in dynamotors of this size, damage can easily result from undercutting to excess at the inner ends of the segment bars.

m. The armature should again be thoroughly tested and inspected for shorts and open windings, using the same precautions as in C above.

n. After thorough cleaning of all housing, bell ends, etc., the unit should be reassembled with new brushes on the proper (low voltage and high voltage) ends.

o. End play in the armature shaft should be adjusted by shimming to between .004 and .007 inches clearance.

p. After visual inspection and ascertaining that the armature is free to rotate, the unit should be reassembled on the power unit and "run-in" for 8 hours with no load.

q. After the "run-in", make visual and final inspection for mechanical noise. Input and output voltages and current values should be verified before returning the unit to service.

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314U-10	28v, 0.04A	GE Mazda 327	262 0179 00
614F-2	28v, 0.04A	GE Mazda 327	262 0179 00

SECTION 10

INSTRUMENT MAINTENANCE AND ADJUSTMENT

10-1. ID-48 DEVIATION INDICATOR.

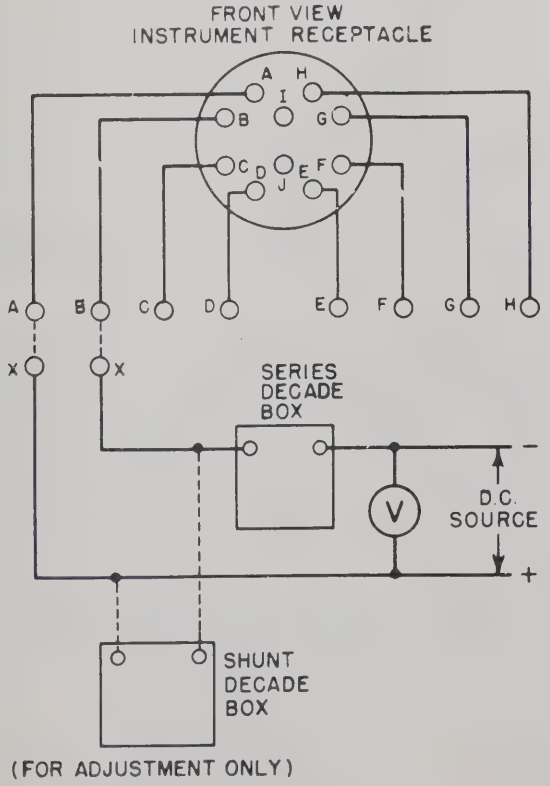
The 51R-3 Receiver uses the Weston Electrical Instrument Corporation Type 888, Type 3 Blind Approach Indicator. (USAF Type ID-48AF/ARN). The following procedure for the maintenance of this instrument is recommended by the Weston Electrical Instrument Corporation.

a. INSTALLATION INSPECTION. - Inspect installation periodically to make certain that the electrical connections are clean and tight and that the insulation on the cables is not frayed or broken. If either the glide slope or localizer pointer does not lie along the corresponding row of dots, the pointer should be reset to the correct position by use of the zero correcting screw on the front of the instrument. Depress the beacon lamp housing to test the operation of the lamp. Lamps which do not light under this test should be replaced.

b. SERVICE TEST. - The indicator should be periodically removed from the cockpit panel and connected in the calibrating circuit shown in figure 10-1. Apply the current indicated below:

Mechanism	Range Microamperes
Localizer	150-0-150
Glide Path	150-0-150
Vertical Flag	125-250
Horizontal Flag	125-250
Beacon Lamp	24 volts

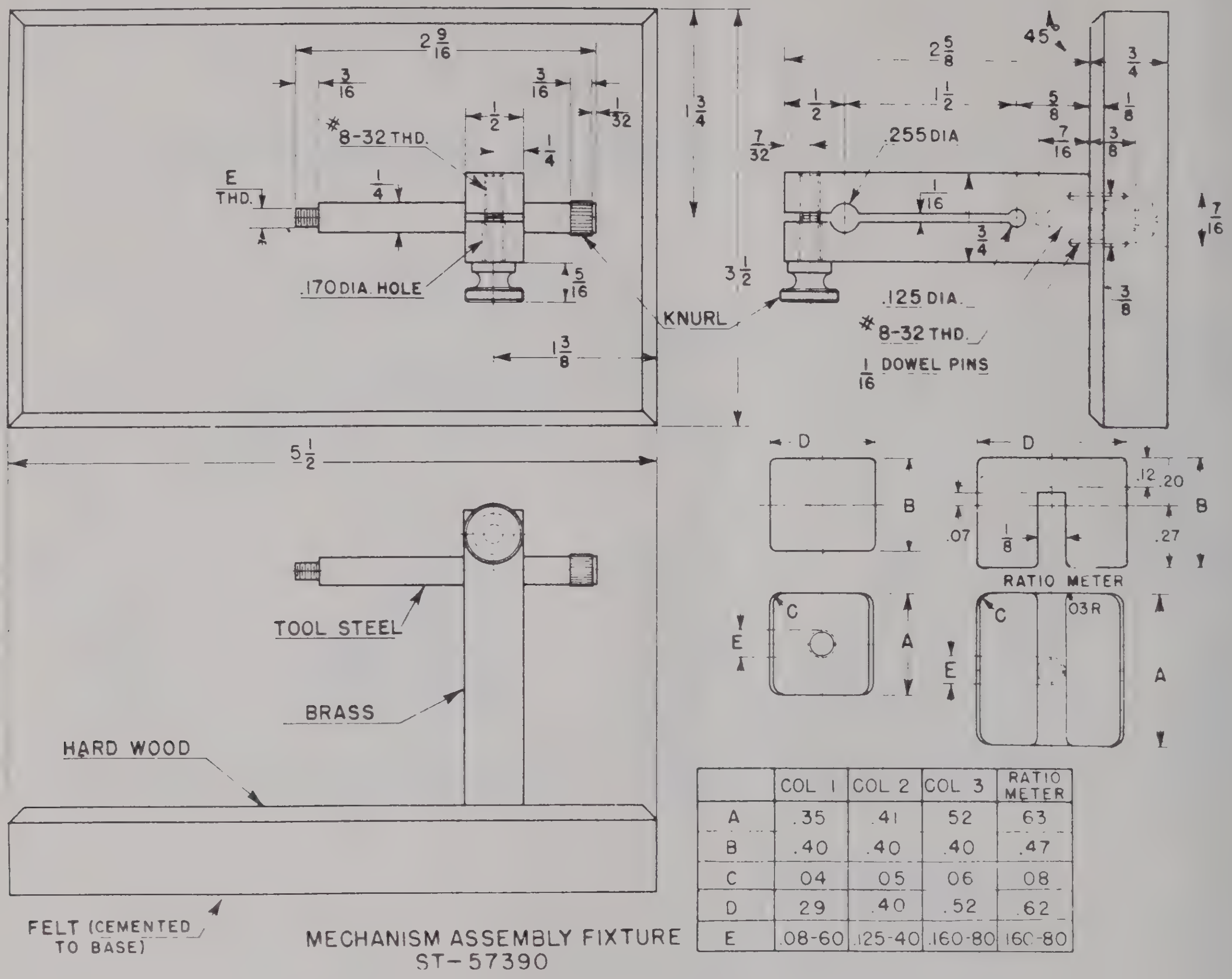
The instrument should next be tested for friction by slowly increasing the current from zero to



CONNECT LEADS X-X TO EACH PAIR OF LEADS IN TURN.

MECHANISM	RECEPTACLE PINS		DEFLECTION
	+	-	
LOCALIZER	A	B	RIGHT
GLIDE PATH	C	D	DOWN
VERTICAL FLAG	E	F	RIGHT
HORIZ. FLAG	G	H	UP

Figure 10-1. ID-48 Adjustment and Calibration Circuit.


2 9/16
3/16
3/16
1/32
1/2
#8-32 THD.
1/4
E THD.
1/4
.170 DIA. HOLE
5/16
1 3/8
1 3/4
3 1/2
KNURL
2 5/8
45°
3/4
1/2
1 1/2
5/8
1/8
7/32
.255 DIA
7/16
3/8
1/16
3/4
7/16
3/8
.125 DIA.
#8-32 THD.
1/16 DOWEL PINS
5 1/2
D
B
A
C
E
.12
.20
.07
1/8
.27
RATIO METER
03R
TOOL STEEL
BRASS
HARD WOOD
FELT (CEMENTED TO BASE)
MECHANISM ASSEMBLY FIXTURE ST-57390

	COL 1	COL 2	COL 3	RATIO METER
A	.35	.41	52	63
B	.40	.40	.40	.47
C	04	05	06	08
D	29	.40	.52	.62
E	.08-60	.125-40	.160-80	160-80

Figure 10-2. Moving Element Assembly Fixture.

full scale value. The pointer motion should be smooth. Any tendency on the part of the pointer to hesitate or stick at a particular place on the scale should be investigated because of the possibility of a foreign particle becoming lodged in the inner gap causing interference with the normal movement of the moving coil. If the instrument adjustment is not within the tolerances stated on the type sheet it will be necessary to readjust the indicator as described under Electrical Adjustment.

c. OVERHAUL TOOLS REQUIRED. - The following list of special tools is required to repair the Model 888 Blind Approach Indicator. The tools can be purchased from the Ideal Laboratory and Tool Supply Company, Cheyenne, Wyoming.

Weston Part Number	Nomenclature	Application
ST2669	Wrench, Socket, .190" Hex.	Moving Movement Bracket
ST18494	Wrench, Socket Insert	Removing Spring Nut
ST19513	Handle, Socket Wrench	Holding ST18494
ST19645	Inserter, Pivot	Inserting Pivot
ST19646	Handle, Pivot Inserter	Holding ST19645
ST54533	Pliers, Pivot Extracting	Removing Pivot
ST54189	Wrench, Spring Balance	Adjusting Balance Weight
ST55559	Wrench, Hex. Balance	Adjusting Tail Weight
ST52680	Wrench, Spiral Balance	Adjusting Tail Weight of ID-48

d. PRE-REPAIR INSPECTION. - Before proceeding with any extensive repairs, it is well to verify defect reports since much time and labor may be saved by correcting superficial defects. Always check the calibration as explained under Electrical Adjustments before removing the instrument case. Rock the instrument from side to side as the current is increased to full scale value and reduce gain to zero to test for hesitation or sticking of the pointers. Friction may be caused by magnetic particles in the air gap, fuzz on the movable coil, core, scale, plate, or pointer or by damaged pivots or jewels. If the mechanism shows friction or is open circuited, proceed with the dis-assembly, re-assembly, and adjustment as indicated below. Dis-assemble the instrument only far enough to reach the indicated fault.

10-2. DEVIATION INDICATOR REPAIR.

If it is found necessary to repair one or more of the moving elements for any reason such as damaged moving coil, broken pointer, damaged springs or worn pivot, the procedure outlined below should be followed. Because of the delicate nature of the parts, repairs should be made by trained instrument mechanics with proper tool facilities.

a. DISASSEMBLY.

(1) Remove the four screws that hold the three pin receptacles to the rear shield. Withdraw the receptacle as far as possible and unsolder the three leads that connect the receptacle to the lamp assembly. All wiring in this instrument is color coded for easy identification.

(2) Remove the four screws that hold the case to the base and carefully lift the case from the instrument proper. The three leads previously unsoldered from the three pin receptacles should be withdrawn from the case. Care should be exercised to prevent the leads from damaging the moving elements and the springs of the adjacent mechanism.

(3) Unsolder the leads of the mechanism to be repaired and remove the screws that hold this mechanism to the support plate.

CAUTION

This operation must be done very carefully to avoid having the magnet attracted to the steel scale plate or to the adjacent magnets with the possibility of damage to the pointers or moving elements. A single mechanism or all four mechanisms may be removed in like manner.

(4) Remove the two screws that hold the Bakelite deck to the magnet. Place the mechanism on a soft iron plate which will act as a keeper for the magnet, diverting the magnetic flux from the air gap and will support the mechanism firmly for further repair operations.

(5) Remove the two screws that hold the movement bracket to the magnetic sector and carefully slide the mechanism back and upward out of the position between the magnet pole pieces.

(6) Unsolder the top and bottom moving element springs from the respective abutments and back out the top jewel screws turning counterclockwise until the moving element falls free of the jewel. Carefully lift the moving element out of the bracket assembly.

(7) Remove the small nuts that hold the pointer and springs of the moving coil. Lift the springs off by grasping the spring terminal with tweezers. Remove the pointer.

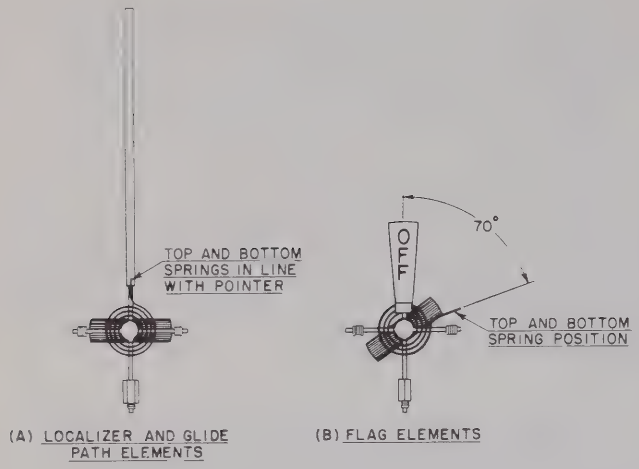
(8) Hold the moving coil between the thumb and index finger and grip the shank of the pivot in a pivot extractor, ST54533, or in the chuck of a jeweler's lather. Turn the moving coil and the pivot in opposite directions while exerting a steady pull. Care should be exercised not to exert too much pressure on the extractor or a broken or damaged coil may result.

b. RE-ASSEMBLY.

(1) Place the moving coil on a moving element assembly fixture as shown in figure 10-2 and using the Pivot Punch, ST19645, and Handle, ST19646, force new pivots into the pivot base. The Pivot Punch is designed to insert the pivots to the proper depth when the end of the punch is in contact with the pivot base.

(2) Remount the springs and pointers and tighten the pivot base nuts in place. Correct position of the pointer spring termination is shown in figure 10-3.

(3) Remove the jewel screws from the movement bracket and clean the jewels by sharpening a wooden match stick to a three-cornered point and twisting it a few times in the pit of the jewel.


TOP AND BOTTOM SPRINGS IN LINE WITH POINTER
OFF
70°
TOP AND BOTTOM SPRING POSITION

(A) LOCALIZER AND GLIDE PATH ELEMENTS

(B) FLAG ELEMENTS

Figure 10-3. Spring Termination

Do not wash the jewels in any form of cleaning fluid. Examine the pit of the jewel for fractures of the surface by probing lightly with a sharp sewing needle, Size #10. Replace jewels where rough surface indicates a fracture.

(4) Place the moving element in the proper position in the bracket assembly and carefully turn the bottom jewel screw in a clockwise direction until the bottom pivot engages the cup of the jewel and the moving coil is lifted clear of the top of the coil. Grasp the pointer lightly and drive the top pivot into the cup of the top jewel while slowly tightening the top jewel screw. Equalize the clearance between the inside top and bottom of the moving coil and the core by alternately adjusting the top and bottom jewel screws.

(5) By blowing lightly on the pointers, adjust the jewel clearance by gradually turning the top jewel screws clockwise until a slight binding of the moving element is apparent. Note the position of the slot in the top jewel screw and turn the jewel counterclockwise one third of a revolution. Particular attention should be given to the shape of the screw driver blade which should be hollow ground to an inch thickness of .009 inch to prevent its being necessary to apply excessive pressure to keep the blade in the jewel screw slot. Do not press too heavily on the screw driver during this adjustment for excess pressure will deflect the blade and result in incorrect jewel clearance or possible damage to pivots or jewels.

(6) Resolder the moving element springs to the respective bridge terminals. Remount the moving bracket in the magnet assembly.

(7) Remove the assembled mechanism from the soft iron plate. Remount the Bakelite deck and assemble the completed mechanism on the support plate.

NOTE

In the event that it is found necessary to recharge the magnet, it is essential that all four magnets be charged so that the poles adjacent to the mechanism are of the same polarity. Figure 10-4 illustrates the polarity of the magnets as the instruments are manufactured. This polarity and the direction of winding of the moving coils is important to the proper deflection of the pointers. Standard practice in regard to the direction of winding the moving coil is to maintain the starter joint on the top pivot space of the right, as viewed from the tail of the pointer. The one exception to this is the vertical flag moving coil on which the starter joint is positioned on the operator's left to provide proper deflection.

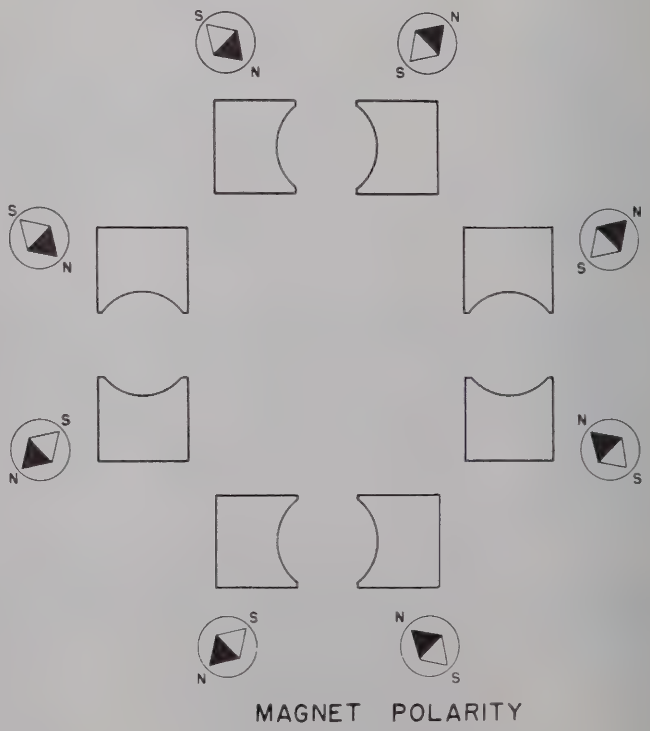


Figure 10-4. ID-48 Magnetic Polarity

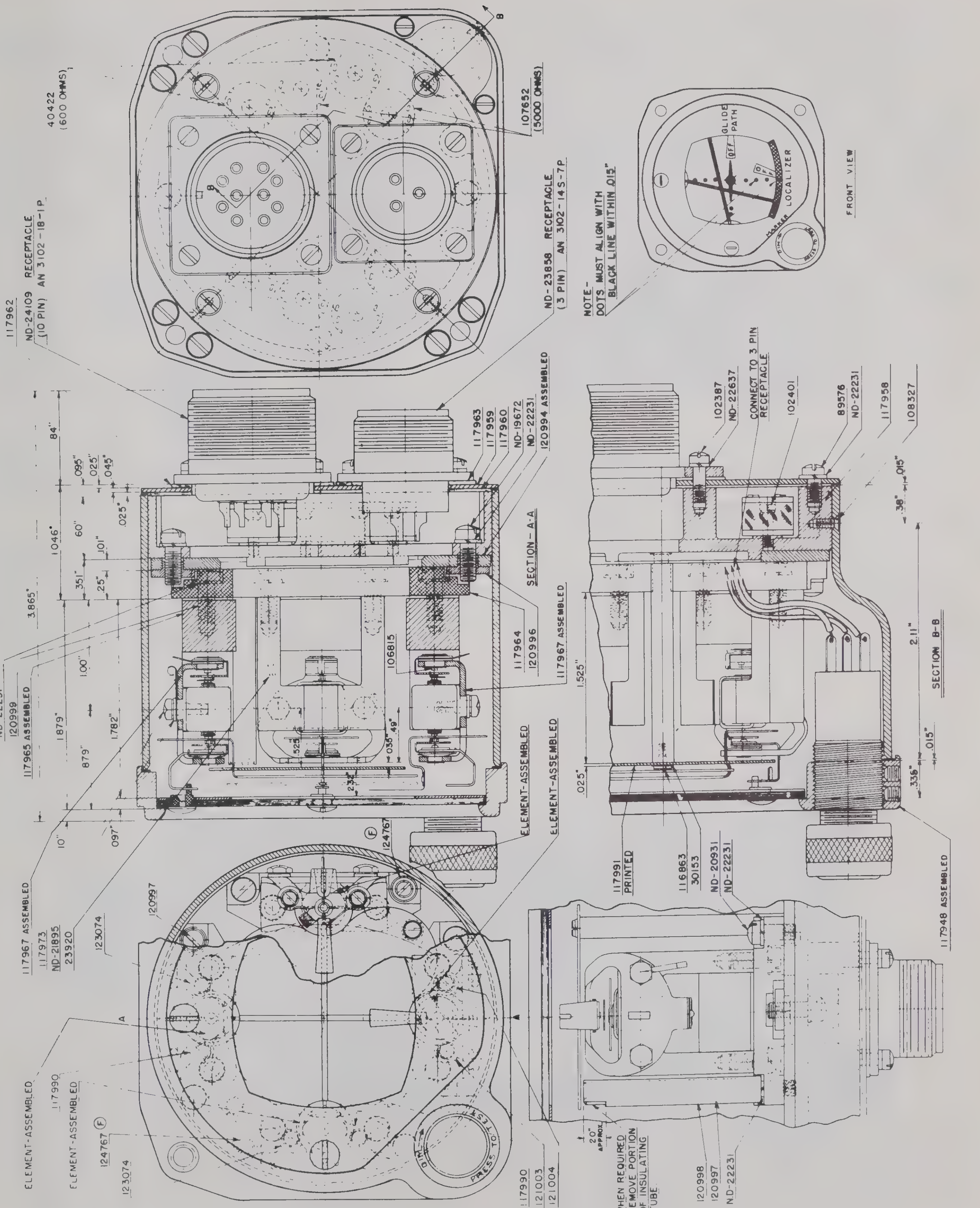

117962
ND-24109 RECEPTACLE
(10 PIN) AN 3102-18-1P
40422
(600 OHMS)
107652
(5000 OHMS)
ND-23858 RECEPTACLE
(3 PIN) AN 3102-14S-7P
NOTE-
DOTS MUST ALIGN WITH
BLACK LINE WITHIN .015"
GLIDE PATH
OFF
LOCALIZER
MARKER
DIM
PRESS TO TEST
FRONT VIEW
B
.84"
.095"
.025"
.045"
.025"
1.046"
.60"
.101"
.351"
.25"
3.865"
1.00"
1.879"
1.782"
.879"
.10"
.097"
117963
117959
117960
ND-19672
ND-22231
120994 ASSEMBLED
SECTION - A-A
117964
120996
117967 ASSEMBLED
106815
.525
.035"
.49"
.234
1.525"
.025"
ND-22231
120999
117965 ASSEMBLED
ELEMENT-ASSEMBLED
ELEMENT-ASSEMBLED
(F)
124767
102387
ND-22637
CONNECT TO 3 PIN
RECEPTACLE
102401
89576
ND-22231
117958
108327
.38"
.015"
2.11"
SECTION B-B
.015"
.336"
117991
PRINTED
116863
30153
ND-20931
ND-22231
117948 ASSEMBLED
117967 ASSEMBLED
117973
ND-21895
23920
123074
120997
A
ELEMENT-ASSEMBLED
117990
ELEMENT-ASSEMBLED
124767 (F)
123074
117990
121003
121004
.20"
APPROX
WHEN REQUIRED
REMOVE PORTION
OF INSULATING
TUBE
120998
120997
ND-22231

Figure 10-5. ID-48 Deviation Indicator Detail Drawing

c. BALANCE ADJUSTMENT. - The following operation should be performed on each mechanism:

(1) Set the instrument on the bench with the scale face upward and set the pointers in the normal zero position by shifting the zero corrector abutment to align the pointers with the corresponding row of dots on the scale. The pointers should be centered over the dots farthest from the pivoted end of the pointer.

(2) Pick up the instrument so that the scale plate is in vertical plane. Note and rotate it until the corresponding row of dots is in horizontal plane. Note position of the pointer and readjust the tail balance weight until the pointer is again aligned with the row of dots. Tap the instrument while performing the operation.

(3) With the scale plate vertical, as before, rotate the instrument until the corresponding row of dots is vertical. Note the position of the pointer and readjust the slide arm valve weight until the pointer is correctly aligned with the dots. Tap the instrument while performing this operation.

(4) Repeat operations (2) and (3). It will probably be found that several adjustments are necessary before the mechanism is properly balanced. The main pointers are within balance limits when the pointers check as in operation (1). A portion of the pointer is within the circumference of the dot in operations (2) and (3).

(5) In making balance adjustment of the flag mechanism, it will be necessary to apply sufficient current to the mechanism to deflect the pointer away from the lower end pointer stop. Balance operation should then proceed as described above.

d. ELECTRICAL ADJUSTMENT.

(1) Mount the case on the instrument temporarily with the two case screws and set the indicator pointers on the normal zero position by means of the zero correcting screws on the front of the glass.

(2) Remove the four screws that hold the ten pin AN receptacle on the rear shield and remove the four screws that fasten the rear shield to the base.

(3) The vertical row of dots on the scale should be aligned with the marks between two sectors printed on the mask within .015 inches. If the vertical row of dots is not in line with the marks it will be necessary to partially loosen the four

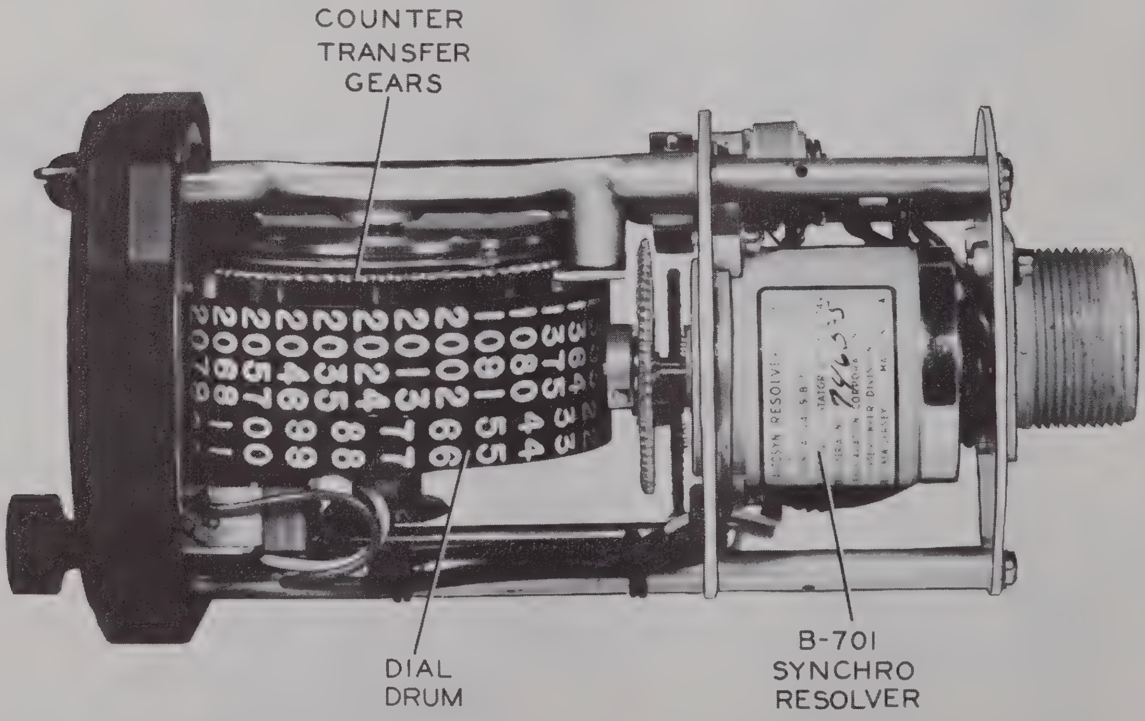


Figure 10-6. 336A-2 Omni-Bearing Selector, Top View

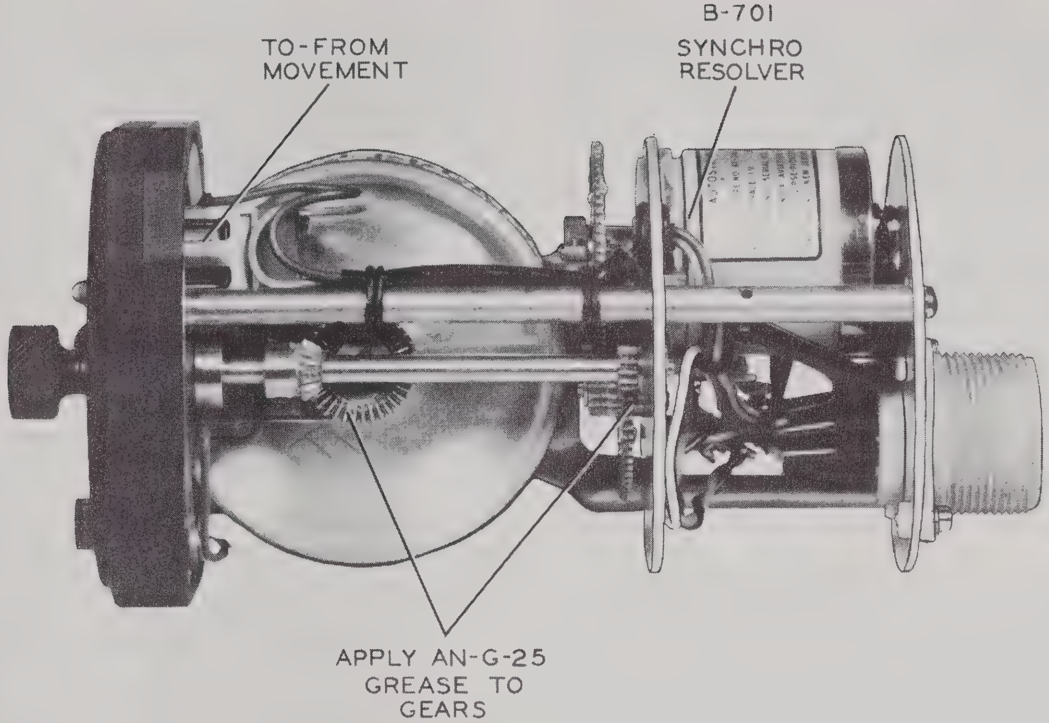


Figure 10-7. 336A-2 Omni-Bearing Selector, Right Side View

adjusting screws located symmetrically around the inner perimeter of the base. The entire mechanism support plates can then be shifted until proper alignment occurs. The adjustment screws should then be tightened.

(4) If a single mechanism has been repaired it will only be necessary to unsolder the shunt spool connected to this mechanism and to connect a short circuiting wire across the series spool of this mechanism in order that the electrical adjustment may be facilitated.

(5) Connect the mechanism in the calibrating circuit and apply the end scale current as indicated. The indicator should rest above the end scale dot and it will be necessary to shunt the dial box to the correct value to provide proper end scale deflection. Currents of less than one milliampere are most conveniently obtained by applying a voltage through a high resistance. A convenient voltage such as 15 volts is selected and the value of the series resistance is determined by Ohms law. The instrument resistance must be subtracted from the calculated resistance. In cases where the moving element will be adjusted by shunting the nominal, approximate resistance of the shunted moving element is subtracted from the calculated value.

(6) The resistance of the moving element should be measured on a Wheatstone bridge and the resistance of the shunted moving element calculated from the equation:

$$\text{R of shunted moving coil} = \frac{R_{me} \times R_{shunt}}{R_{me} + R_{shunt}}$$

The series resistance is then calculated by subtracting the shunted moving element resistance from the total resistance as given on the type sheet. For example, assuming a moving element resistance of 638 ohms, a shunt resistance of 750 ohms, and a desired total resistance of 1000 ohms, then $R_{me} = \frac{638 \times 750}{638 + 750} = 345$ ohms.

$R_{series} = R_t - R_{me} = 1000 - 345 = 655$ ohms. The shunted series resistance spools should then be adjusted to the necessary values and the spools mounted in position and connected in the circuit. The desired shunt resistor can be adjusted to the proper value, connected in place, and a dial box connected in series. The combination is next connected to a Wheatstone Bridge to measure the desired total resistance when balanced. The dial box is then adjusted so that a balance is obtained and the necessary series resistance read directly from the dial box.

e. FLAG MECHANISM ADJUSTMENT. - Adjustment of the flag mechanisms will require alternate adjustments of the shunt dial box and the top spring abutment to achieve the proper deflection. The flag mechanism is adjusted so that with the low-end current applied, the flag pointer partially covers the row of dots and with the high-end current applied, the flag pointer is out of sight under the edge of the mask. Proceed as outlined below:

(1) Connect the flag mechanism (shunt and series resistors cut out of the circuit as in (4) above) in the calibrating circuit and note the current required to deflect the flag to the normal off current position over the dots on the scale. Apply and note the current required to bring the flag just out of sight under the mask. The difference between the high-end current and the low-end current should be less than 250 minus 125 microamperes or 125 microamperes. If the difference is greater than 125 microamperes, it will be necessary to recharge the magnet.

(2) Apply 125 microamperes and adjust to the low end position (over the scale dots) by moving the top spring abutment.

(3) Apply 250 microamperes and adjust the shunt dial box until the flag is just covered by the mask.

(4) Apply 125 microamperes and readjust the abutment to correct the low end indication.

(5) Apply 250 microamperes and again shunt until the flag is just covered.

(6) Alternately apply 125 microamperes and adjust the abutment and 250 microamperes and shunt until the adjustment is within the limits of 125 ±6 microamperes at the low-end and about 250 ±12.5 microamperes at the high-end position.

(7) Adjust the low-end pointer stop to maintain the off-current position of the flag over the associated main pointer.

(8) Adjust the shunt and series resistors to the necessary resistance and mount the resistors in place.

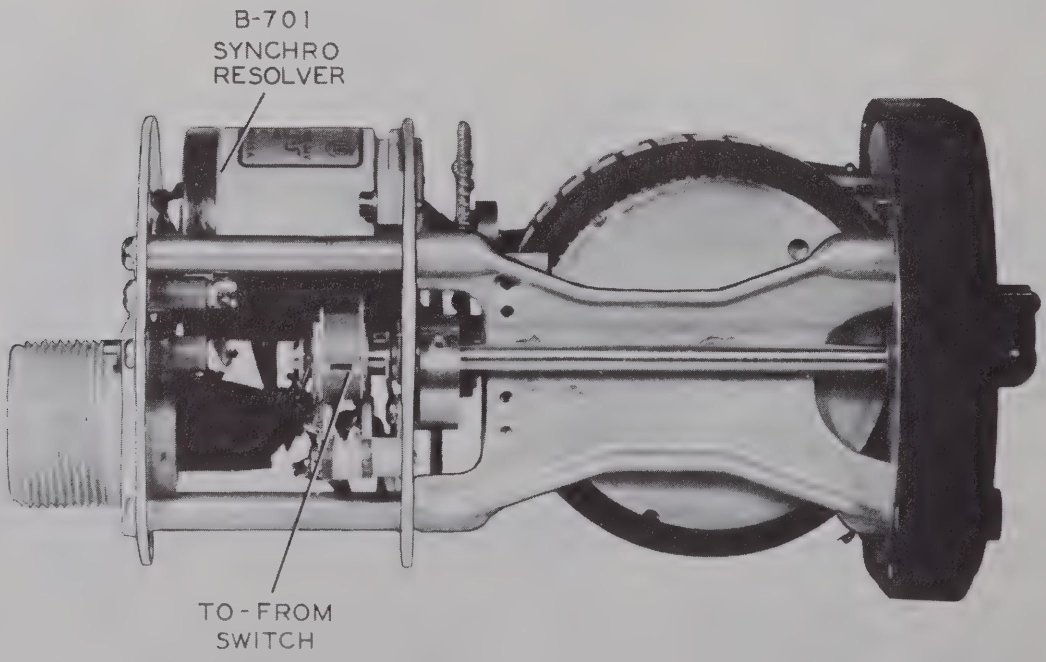


Figure 10-8. 336A-2 Omni-Bearing Selector, Left Side View

(9) Adjust the main pointer stops to permit the pointers to deflect slightly past the end dots but short of interferring with the motion of the other main pointers at the point of greatest deflection.

(10) Remount the rear plate and 10-pin receptacle taking care that the leads to the spools are not compressed between the base supports and the plate and that the soldered joints on the spools do not touch the rear plate gasket. Compression of the leads, or soldered joints penetrating the gasket will eventually ground the circuit interferring with the proper operation of the system.

(11) Remove the case and inspect the internal parts, removing particles from the air gap, fuzz from scale and pointers, etc. Remount the case and reconnect and mount the 3-pin receptacle. The instrument is then ready for a final electrical check and service.

10-3. OMNI BEARING SELECTOR.

a. PROPER ROTATION.

(1) The resolver rotor is rotated in a clockwise direction when the selector knob is rotated clockwise. This also causes the MAGNETIC BEARING indication, as read through the window, to indicate higher numbers as the selector is rotated clockwise. Positioning the TO-FROM toggle does not affect the above.

(2) When flying a course zero degrees TO a VOR station from a position south of that station, a properly connected OBS will cause the Deviation Indicator to deflect right if a course change toward a westerly direction is pursued.

(3) When condition (2) exists, the Deviation Indicator should become centered as the OBS is rotated toward the higher numbers.

b. ELECTRICAL ZERO PROCEDURE. - (To be employed where the preferred ORZ procedure outlined in paragraph 10-5 cannot be followed.)

SYNCHRO RESOLVER (manual phase shifter).

(1) Adjust bearing to read 300 deg. with TO-FROM toggle in counterclockwise position.

(2) Apply approximately 26 volt 400 cps to Red (F) rotor lead with Black (E) rotor lead grounded.

(3) Rotate resolver frame in its mount until a minimum voltage is observed between the Red (B) stator and Red (F) rotor (both the Black (A) stator and Black (E) rotor grounded.

(4) Next connect meter between Blue (D) and Yellow (C) stator wires and adjust frame for precise null.

(5) Without disturbing null achieved in step (d), clamp resolver firmly in its mount.

c. WINDING RESISTANCE.

(1) SYNCHRO RESOLVER.

a. Rotor should have approximately 230 ohms d-c resistance.

b. Stators should have approximately 170 ohms d-c resistance, and on a given resolver should agree within 4 ohms d-c of each other.

(2) TO-FROM METER. - This is a 250-0-250 d-c microammeter with a d-c winding resistance of 100 ohms ±20%. With positive voltage applied to pin G the meter deflects toward "TO".

d. ILLUMINATION. - The source of illumination is a 3 volt, 190 millampere bulb, connections to what are provided at pins J and I, with the latter connected to the instrument frame.

e. LUBRICATION.

(1) GEAR TRAIN. - A thin coating (0.005 to 0.010 inch) of ANG-25 grease (or equivalent) is recommended.

(2) RESOLVER. - If, during a major overhaul inspection, the ball bearings appear dry, one or two drops of AN-O-4 oil (or equivalent) properly placed should suffice.

(3) REAR CONNECTOR THREADS. - The rear connector threads should be coated lightly with a compound such as DC-4 to facilitate mating connector removal.

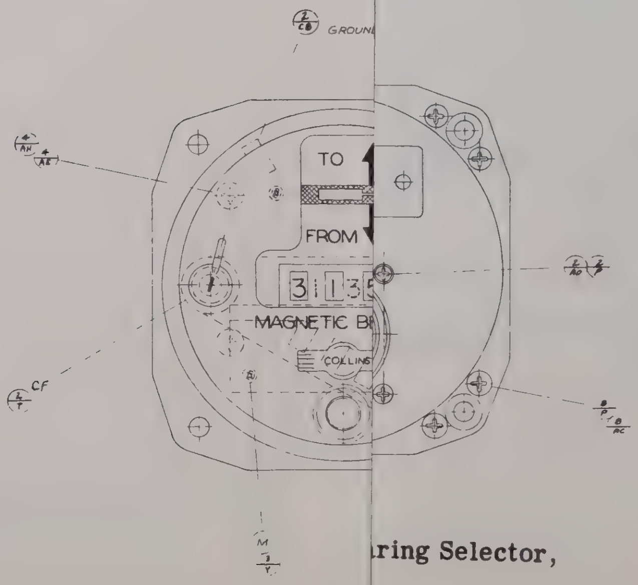
10-4. 'OMNI BEARING INDICATOR.

a. PROPER ROTATIONS. - With terminals connected as shown in figure 12-2, shaft rotations will be as follows when facing the omni bearing indicator dial.

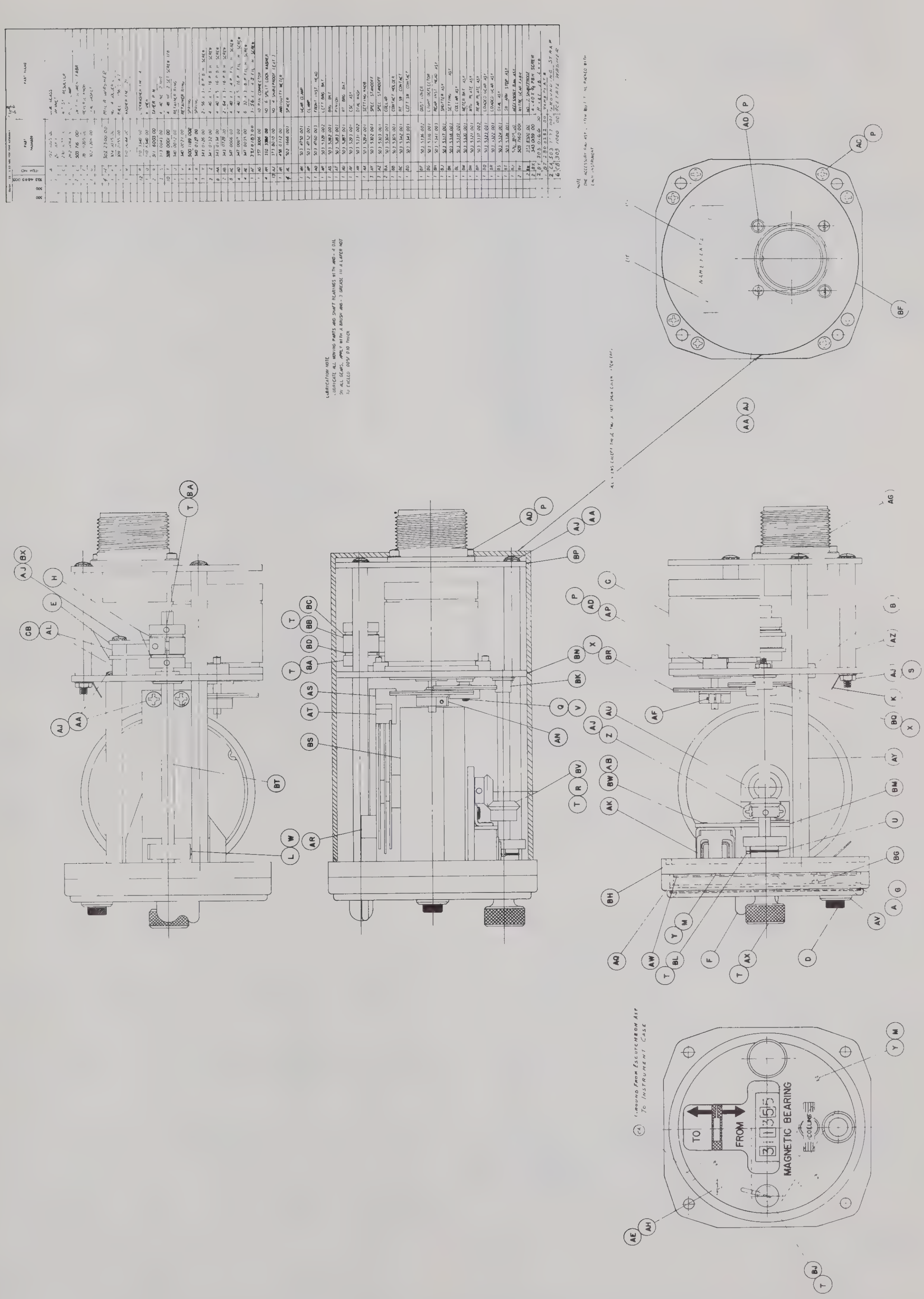
ITEM NO.	PART NUMBER	PART NAME
A	192 1005 00	DIAL GLASS
B	201 0001 00	GROMMET
C	230 0077 00	AUTOSYN RESOLVER
D	262 0064 00	PILOT LAMP
E	503 7161 001	SW. SEG. FABR.
F	281 0205 00	REVERSE KNOB
G	302 0206 00	DIAL GASKET
H	302 2300 00	MICA WASHER
K	304 0015 00	SOLDER LUG (NO. 4)
L	309 0155 00	BALL (156 DIA.)
M	310 0053 00	WASHER (NO. 12)
N	504 4506 001	SPRING WASHER
P	310 0076 00	LOCKWASHER (NO. 4)
Q	310 6340 00	WASHER
R	310 0166 00	WASHER
S	310 4280 00	SPRING WASHER
T	328 0001 00	4 - 48 NF - 2 SET SCREW 1/8
U	340 0090 00	RETAINING RING
V	340 0021 00	RETAINING RING
W	500 1189 002	SPRING
X	340 0127 00	SPRING
Y	343 0301 00	2 - 56 X 3/8 P.B. HD. SCREW
Z	342 0154 00	4 - 40 X 3/8 P.F. HD. SCREW
AA	343 0286 00	4 - 40 X 5/16 P. B. HD. SCREW
AB	321 0193 00	2 - 64 X 3/8 S. FIL. HD SCREW
AC	347 0090 00	4 - 40 X 1/4 P. FIL. HD. SCREW
AD	347 0091 00	4 - 40 X 5/16 P. FIL. HD SCREW
AE	347 0171 00	6 - 32 X 3/8 P. FIL. HD. SCREW
AF	321 0187 00	3 - 56 X 1/4 S. FIL. HD. SCREW
AG	357 3006 00	PIN CONNECTOR
AH	310 0077 00	SPLIT LOCK WASHER (NO. 6)
AJ	373 7010 00	SHAKEPROOF (EXT. NO. 4)
AK	458 0112 00	AMBIGUITY METER
AL	502 1666 001	SPACER
AM	306 0091 00	TERMINAL
AN	503 4750 001	GEAR CLAMP
AP	503 4752 001	CLAMP
AQ	503 4760 003	FRONT INST. HD.

ITEM NO.	PART NUMBER
AR	504 2625 001
AS	504 2634 001
AT	504 2646 001
AU	504 2638 001
AV	503 5293 001
AW	503 5331 002
AX	503 5294 001
AY	504 2629 001
AZ	504 2630 001
BA	503 5304 001
BB	503 5305 001
BC	503 5342 001
BD	503 5343 001
BE	504 2642 001
BF	504 2663 002
BG	503 5316 001
BH	504 2631 001
BL	422 4000 00
BM	504 2633 001
BN	504 2627 001
BP	504 2628 001
BQ	504 2640 001
BR	504 2643 001
BS	504 2653 001
BT	504 2656 001
BU	520 3905 00
BV	504 2657 001
BW	504 2658 001
BX	310 6230 00
BY	343 0290 00
BZ	305 0166 00
CA	280 0252 00
CB	503 7577 001
CC	343 0284 00
CD	310 0054 00
CE	504 2626 001
CF	503 5317 001
CG	502 1145 002
CH	502 1146 002

x.



ring Selector,


NAMEPLATE
AD
P
AC
BF
AA
AJ
BA
T
AJ
BX
H
E
AL
CB
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BT
L
W
AR
BC
BB
BD
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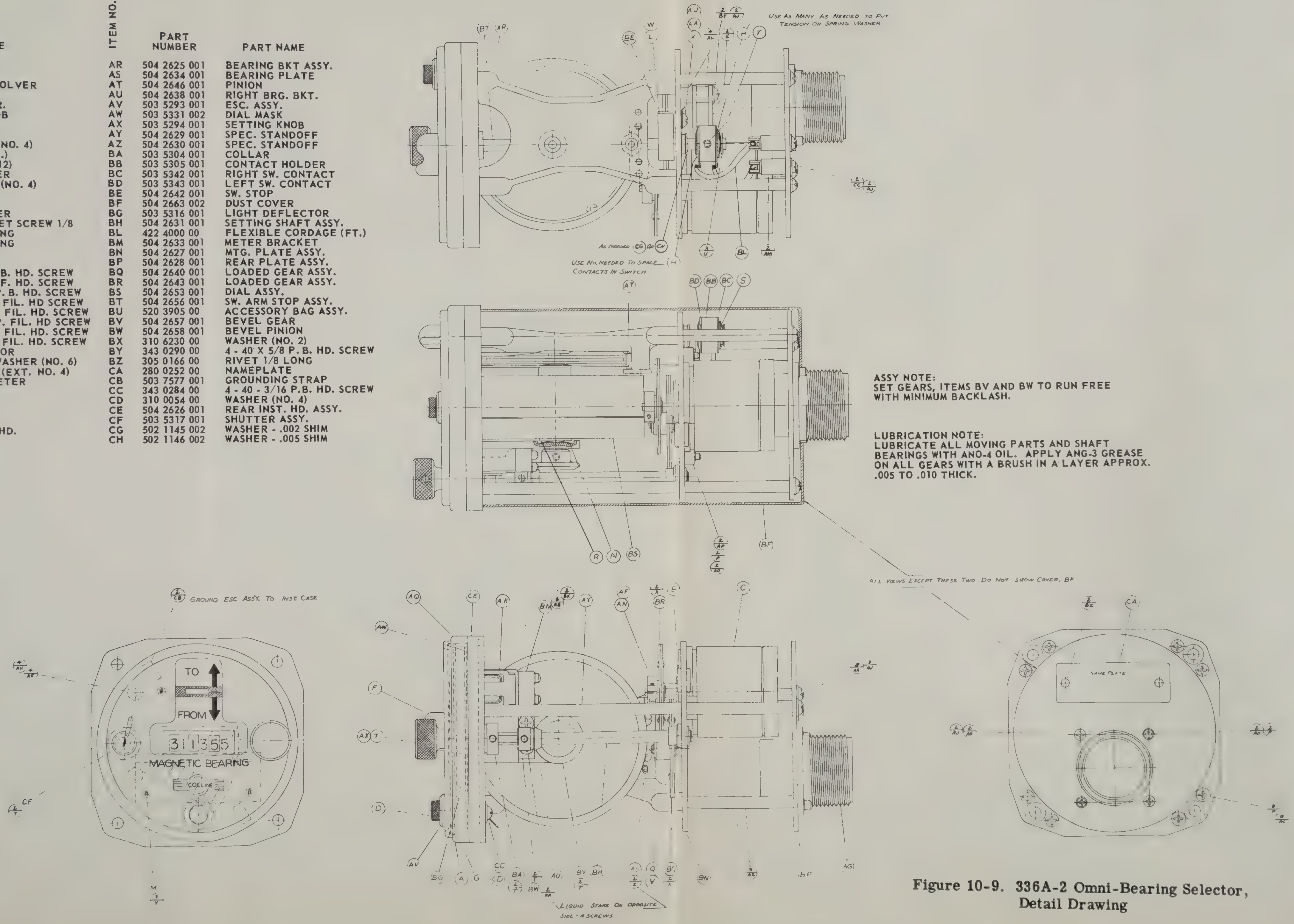
A
AV
D
AX
F
M
Y
BL
AW
AQ
TO
FROM
MAGNETIC BEARING
COLLINS
AE
AH
BJ
GROUND FROM ESCUTCHEON ASY TO INSTRUMENT CASE

Figure 10-10. 336A-1 Omni-Bearing Selector, Detail Drawing

ITEM NO.	PART NUMBER	PART NAME
A	192 1005 00	DIAL GLASS
B	201 0001 00	GROMMET
C	230 0077 00	AUTOSYN RESOLVER
D	262 0064 00	PILOT LAMP
E	503 7161 001	SW. SEG. FABR.
F	281 0205 00	REVERSE KNOB
G	302 0206 00	DIAL GASKET
H	302 2300 00	MICA WASHER
K	304 0015 00	SOLDER LUG (NO. 4)
L	309 0155 00	BALL (156 DIA.)
M	310 0053 00	WASHER (NO. 12)
N	504 4506 001	SPRING WASHER
P	310 0076 00	LOCKWASHER (NO. 4)
Q	310 6340 00	WASHER
R	310 0166 00	WASHER
S	310 4280 00	SPRING WASHER
T	328 0001 00	4 - 48 NF - 2 SET SCREW 1/8
U	340 0090 00	RETAINING RING
V	340 0021 00	RETAINING RING
W	500 1189 002	SPRING
X	340 0127 00	SPRING
Y	343 0301 00	2 - 56 X 3/8 P.B. HD. SCREW
Z	342 0154 00	4 - 40 X 3/8 P.F. HD. SCREW
AA	343 0286 00	4 - 40 X 5/16 P. B. HD. SCREW
AB	321 0193 00	2 - 64 X 3/8 S. FIL. HD SCREW
AC	347 0090 00	4 - 40 X 1/4 P. FIL. HD. SCREW
AD	347 0091 00	4 - 40 X 5/16 P. FIL. HD SCREW
AE	347 0171 00	6 - 32 X 3/8 P. FIL. HD. SCREW
AF	321 0187 00	3 - 56 X 1/4 S. FIL. HD. SCREW
AG	357 3006 00	PIN CONNECTOR
AH	310 0077 00	SPLIT LOCK WASHER (NO. 6)
AJ	373 7010 00	SHAKEPROOF (EXT. NO. 4)
AK	458 0112 00	AMBIGUITY METER
AL	502 1666 001	SPACER
AM	306 0091 00	TERMINAL
AN	503 4750 001	GEAR CLAMP
AP	503 4752 001	CLAMP
AQ	503 4760 003	FRONT INST. HD.

ITEM NO.	PART NUMBER	PART NAME
AR	504 2625 001	BEARING BKT ASSY.
AS	504 2634 001	BEARING PLATE
AT	504 2646 001	PINION
AU	504 2638 001	RIGHT BRG. BKT.
AV	503 5293 001	ESC. ASSY.
AW	503 5331 002	DIAL MASK
AX	503 5294 001	SETTING KNOB
AY	504 2629 001	SPEC. STANDOFF
AZ	504 2630 001	SPEC. STANDOFF
BA	503 5304 001	COLLAR
BB	503 5305 001	CONTACT HOLDER
BC	503 5342 001	RIGHT SW. CONTACT
BD	503 5343 001	LEFT SW. CONTACT
BE	504 2642 001	SW. STOP
BF	504 2663 002	DUST COVER
BG	503 5316 001	LIGHT DEFLECTOR
BH	504 2631 001	SETTING SHAFT ASSY.
BL	422 4000 00	FLEXIBLE CORDAGE (FT.)
BM	504 2633 001	METER BRACKET
BN	504 2627 001	MTG. PLATE ASSY.
BP	504 2628 001	REAR PLATE ASSY.
BQ	504 2640 001	LOADED GEAR ASSY.
BR	504 2643 001	LOADED GEAR ASSY.
BS	504 2653 001	DIAL ASSY.
BT	504 2656 001	SW. ARM STOP ASSY.
BU	520 3905 00	ACCESSORY BAG ASSY.
BV	504 2657 001	BEVEL GEAR
BW	504 2658 001	BEVEL PINION
BX	310 6230 00	WASHER (NO. 2)
BY	343 0290 00	4 - 40 X 5/8 P. B. HD. SCREW
BZ	305 0166 00	RIVET 1/8 LONG
CA	280 0252 00	NAMEPLATE
CB	503 7577 001	GROUNDING STRAP
CC	343 0284 00	4 - 40 - 3/16 P.B. HD. SCREW
CD	310 0054 00	WASHER (NO. 4)
CE	504 2626 001	REAR INST. HD. ASSY.
CF	503 5317 001	SHUTTER ASSY.
CG	502 1145 002	WASHER - .002 SHIM
CH	502 1146 002	WASHER - .005 SHIM



USE AS MANY AS NEEDED TO PUT TENSION ON SPRING WASHER
AS NEEDED CG OR CH
USE NO. NEEDED TO SPACE CONTACTS IN SWITCH
GROUND ESC ASSY. TO INST. CASE
ALL VIEWS EXCEPT THESE TWO DO NOT SHOW COVER, BF
TO
FROM
31355
MAGNETIC BEARING
COLLINS
NAME PLATE
LIQUID STAKE ON OPPOSITE SIDE - 4 SCREWS
AJ
AA
AR
BT
W
L
BE
K
H
T
BG
BL
AM
AT
BD
BB
BC
S
R
N
BS
BF
AQ
CE
AK
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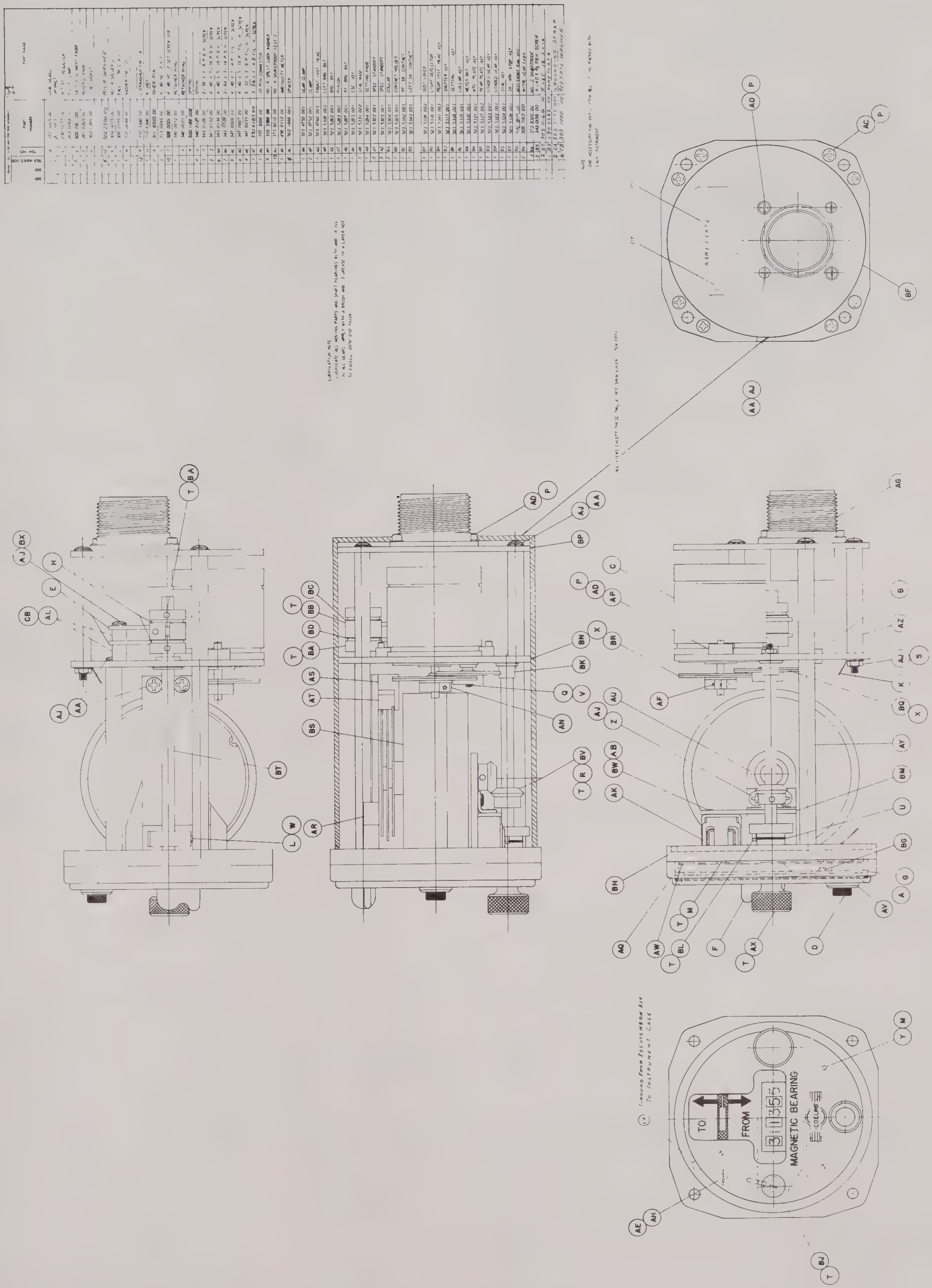
BR
C
AW
F
AX
D
AV
BG
A
G
CC
CD
BA
BW
AU
BV
BH
Q
V
BN
BP
AG
CF
CA

ASSY NOTE:
SET GEARS, ITEMS BV AND BW TO RUN FREE WITH MINIMUM BACKLASH.

LUBRICATION NOTE:
LUBRICATE ALL MOVING PARTS AND SHAFT BEARINGS WITH ANO-4 OIL. APPLY ANG-3 GREASE ON ALL GEARS WITH A BRUSH IN A LAYER APPROX. .005 TO .010 THICK.

Figure 10-9. 336A-2 Omni-Bearing Selector, Detail Drawing


TO
FROM
MAGNETIC BEARING
COLLINS
AD P
AC P
BF
AA AJ
T BA
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H
E
CB
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L W
AD
P
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Figure 10-10. 336A-1 Omni-Bearing Selector, Detail Drawing

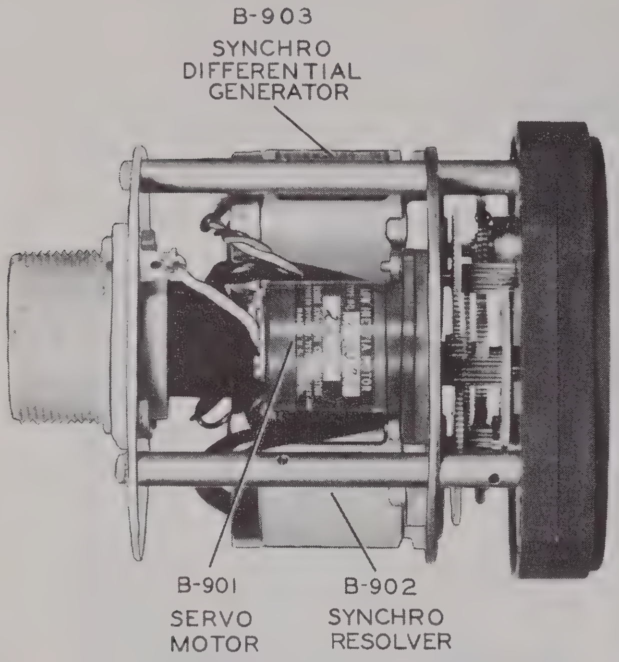


Figure 10-11. 337A-2 Omni-Bearing Indicator, Top View

(1) Dial will rotate counterclockwise toward larger numbers as a westerly course is pursued from a position south of a VOR position.

(2) Differential generator, B-903, will rotate clockwise when condition (1) exists. See figure 10-11 for location.

(3) Synchro resolver, B-902, will rotate clockwise when condition (1) exists. See figure 10-11.

(4) Two-phase motor, B-901, will rotate counterclockwise when condition (1) exists.

b. ELECTRICAL ZERO PROCEDURE.

(1) DIFFERENTIAL GENERATOR.

(a) Connect Blue-Yellow rotor leads (pins L and M).

(b) Apply 15 volt 400 cps between leads as connected in (a) and the grounded black rotor (K) lead.

(c) Temporarily connect Blue-Yellow stator leads (pins H and J).

(d) Position rotor for minimum voltage between the connected Blue-Yellow rotor leads and the connected Blue-Yellow stator leads. This minimum should be 2 or 3 volts.

(e) Disconnect Blue-Yellow stator leads and carefully adjust rotor position for null measured between the Blue (H) and Yellow (J) stators.

(f) Without disturbing the rotor position with respect to its stator clamp OBI dial to read 180 degrees.

(g) Recheck null after clamping.

(2) SYNCHRO RESOLVER, B-902, (Automatic Phase Shifter). (To be employed where the preferred ORZ Procedure outlined in paragraph 10-5 cannot be followed.)

(a) Adjust OBI dial and gear train to read 300 degrees against lubber line.

(b) Apply approximately 26 volts 400 cps to Red (F) rotor lead with Black (E) rotor lead grounded.

(c) Rotate resolver frame in its mount until a minimum voltage is observed between the Red (B) stator and the Red (F) rotor (both black (A) stator and Black (E) rotor grounded.)

(d) Next connect meter between Blue (D) and Yellow (C) stators, and adjust for a precise null.

(e) Without disturbing null achieved in (d) clamp resolver firmly in its mount.

c. MOTOR ROTATION.

(1) DIRECTION OF ROTATION.

(a) Connect Black (N) and Blue (S) to low side of a 12-18 volt 400 cycle source.

(b) Connect Red (P) to Orange (R) through a 2 microfarad capacitor.

(c) Connect the high side of the 12-18 volt 400 cps source to Red (P).

(d) Dial should rotate toward decreasing numbers.

(2) SPEED. - OBI dial should reverse (0 to 180 degrees) in approximately 5 seconds when driven by servo circuit.

QUANTITY	ITEM NO	QUANTITIES ARE FOR ONE ASSEMBLY		
		COLLINS PART NUMBER	GOVERNMENT PART NO	PART NAME
1	A	504 3182 001		PINION AND GEAR ASSY.,
1	B	504 3184 001		PINION AND GEAR ASSY.,
1	C	504 3186 001		PINION AND GEAR ASSY.,
1	D	504 3180 001		SHAFT AND GEAR ASSY.,
2	E	503 4759 002		SPRING LOADED GEAR ASSY.,
1	F	504 3175 001		CONNECTOR PLATE ASSY.,
1	G	503 4743 001		DIAL ASSY., (SEE NOTE)
1	H	230 0107 00		MOTOR
1	J	230 0077 00		RESOLVER
1	K	230 0076 00		AUTOSYN
1	L	302 0206 00		DIAL GASKET
1	M	192 1903 00		DIAL GLASS
1	N	357 3003 00		CONNECTOR
4	P	340 0127 00		SPRING
4	Q	503 4752 001		CLAMP
2	R	503 4750 001		GEAR CLAMP
1	S	503 4754 002		MASK
2	T	503 4734 001		SPL. STANDOFF
1	U	504 3190 00[illegible]		REAR INST., HEAD
1	V	503 4760 003		FRONT INST., HEAD
1	W	503 4751 001		SPL., STANDOFF
3	X	503 4735 001		SPL., STANDOFF
1	Y	504 3187 002		BEARING PLATE - REAR
1	Z	503 4755 002		DUST COVER
1	AA	504 3188 002		BEARING PLATE - FRONT
1	AB	504 3176 001		SPACER MOTOR
2	AC	321 0187 00		3-56 X 1/4 , FIL., HD., SCREW
9	AD	347 0006 00		4-40 X 1/4 FIL., HD., SCREW
6	AE	347 0007 00		4-40 X 5/16 FIL., HD., SCREW
5	AF	343 0134 00		4-40 X 5/16 BD., HD., SCREW
14	AG	310 3340 00		NO. 4 LOCKWASHER
5	AH	373 8010 00		NO. 4 SHAKEPROOF (EXT.)
2	AJ	343 0125 00		NO., 2-56 X 5/16 BD., HD., SCREW
2	AK	373 8500 00		NO., 2 SHAKEPROOF
1	AL	304 3110 00		SOLDERING LUG
1	AM	313 0043 00		NO. 4-40 HEX NUT
1	AN	280 0252 00		NAMEPLATE
2	AP	305 0166 00		RIVET - 1/8 LONG
1	AQ	520 3905 00		ACC., BAG ASSY.,

NOTE
ONE ACCESSORY BAG ASSY., ITEM (AQ), TO BE PACKED WITH EACH INSTRUMENT BEFORE SHIPMENT.

LUBRICATION NOTE: APPLY ANO-4 OIL TO ALL SHAFT BEARINGS AS MUCH AS THEY WILL HOLD BUT NO EXCESS. APPLY ANG 3 GREASE ON ALL GEARS WITH A BRUSH IN A LAYER .005 TO .010 THICK.

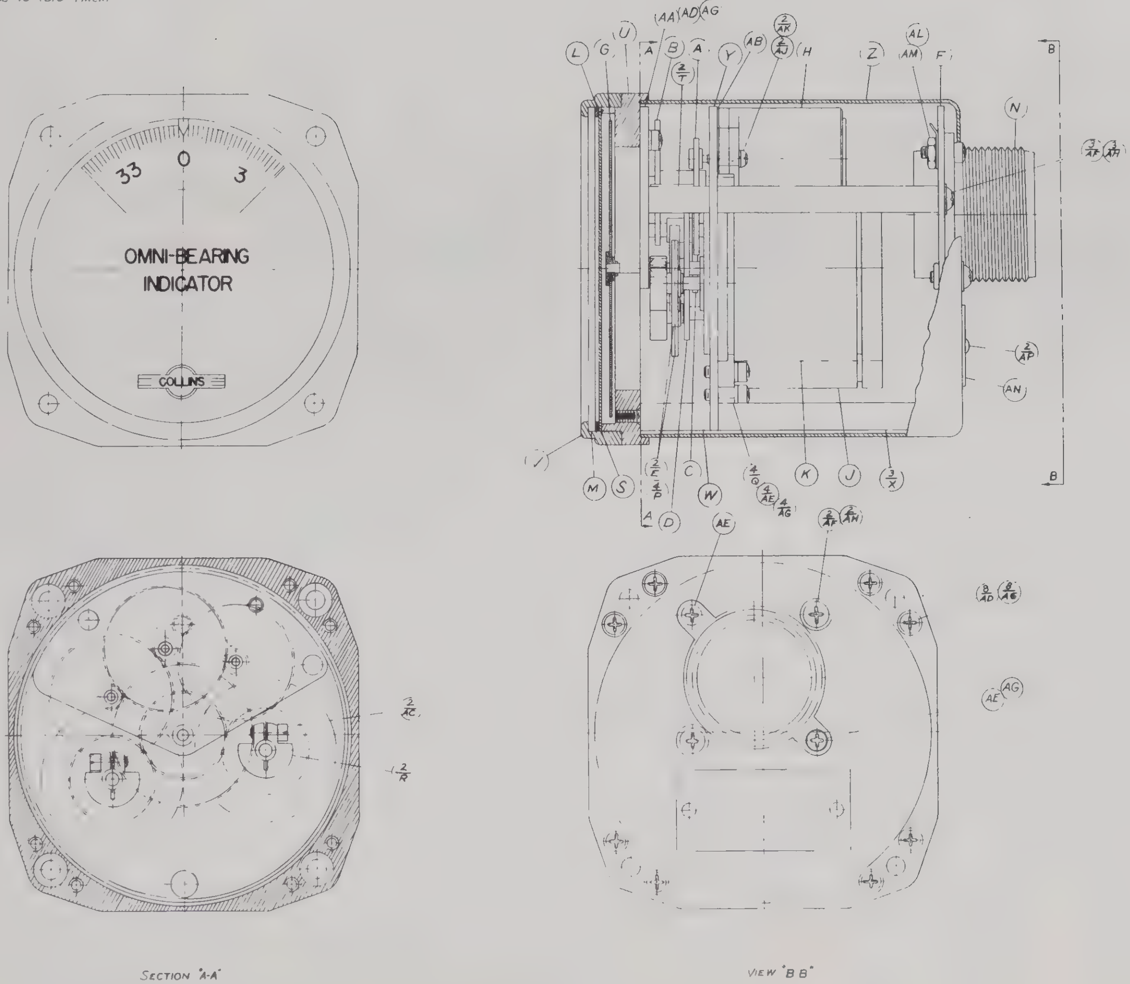
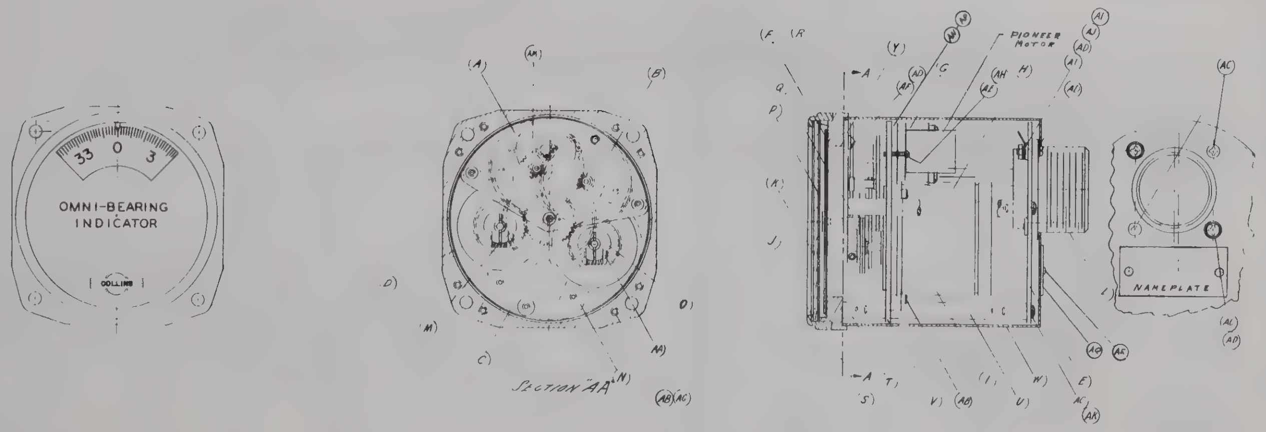


Figure 10-12. 337A-2 Omni-Bearing Indicator, Detail Drawing

QUANTITIES LISTED ARE FOR ONE ASSEMBLY					A.
300	500	503 4886 004	ITEM NO.	PART NUMBER	PART NAME
		1	A	503 4738 001	PINION GEAR ASSY.
		1	B	503 4737 001	PINION GEAR ASSY
		1	C	503 4742 001	SHAFT GEAR ASSY
		2	D	503 4759 002	SPRING LOADED GEAR ASSY.
		1	E	503 4744 001	CONNECTOR PLATE ASSY.
		1	F	503 4743 001	DIAL ASSY. (SEE NOTE)
		1	G	230 0107 00	MOTOR (SEE "G" BELOW)
		1	H	230 0077 00	RESOLVER
		1	I	230 0076 00	AUTOSYN
		1	J	302 0206 00	DIAL GASKET
		1	K	192 1003 00	DIAL GLASS
		1	L	357 3003 00	CONNECTOR
		4	M	340 [illegible] 1 00	SPRING
		4	N	503 4752 001	CLAMP
		2	O	503 4750 001	GEAR CLAMP
		1	P	503 4754 002	MASK
		2	Q	503 4734 001	SPL. STAND OFF
		1	R	503 4761 003	REAR INSTRUMENT HEAD
		1	S	503 4760 003	FRONT INSTRUMENT HEAD
		1	T	503 4751 001	SPL. STAND OFF
		3	U	503 4735 001	SPL. STAND OFF
		1	V	503 4758 002	BEARING PLATE
		1	W	503 4755 002	DUST COVER
		1	Y	503 4757 002	BEARING PLATE
		2	AA	321-0187-00	3-56-1/4 FIL HD SCREW
		12	AB	347 0006 00	4 40-1/4 FIL HD SCREW
		6	AC	343 0134 00	4-40-5/16 BD HD SCREW
		4	AD	373 0006 00	#4 SHAKEPROOF (INT.)
		2	AE	343 0127 00	2-56-7/16 BD HD SCREW
		1	AF	343 0285 00	4-40-1/4 BD HD SCREW
		8	AG	310 3240 00	#4 LOCKWASHER
		2	AH	373 8500 00	#2 SHAKEPROOF
		1	AI	304 0015 00	SOLDERING LUG
		1	AJ	313 0043 00	4-40 HEX HD NUT
		3	AK	373 8010 00	#4 SHAKEPROOF (EXT.)
		1	AL	343 0195 00	4 40-3/8 BD HD SCREW
		1	G	503 5433 002	MOTOR ASSY (ALTERNATE)
		1	A	520 3905 00	ACC. BAG ASSY.
		1	AM	503 7582 001	GEAR & PINION ASY
		1	AN	503 7578 001	CENTERING BUSHING
		1	AP	503 7579 001	MOTOR SPACER PLATE
		1	AQ	280 0252 00	NAMEPLATE
		2	AR	305 0166 00	RIVET-1/8 LONG

LUBRICATION NOTE:
APPLY ANO-4 OIL TO ALL SHAFT BEARINGS, AS MUCH AS THEY WILL HOLD BUT NO EXCESS.

ON ALL GEARS. APPLY WITH A BRUSH ANG-3 GREASE IN A LAYER NOT TO EXCEED .005-.010 THICK..



NOTE:
ONE ACCESSORY BAG ASY., ITEM (AM) TO BE PACKED WITH EACH INSTRUMENT BEFORE SHIPMENT..

Figure 10-13. 337A-1 Omni-Bearing Indicator, Detail Drawing

d. WINDING RESISTANCES.

(1) DIFFERENTIAL AUTOSYN.

(a) Ohmmeter should indicate approximately 6 ohms d-c resistance between any two rotor leads.

(b) Ohmmeter should indicate approximately 6 ohms d-c resistance between any two stator leads.

(2) SYNCHRO RESOLVER, B-902 (Automatic Phase Shifter.)

(a) Rotor should read approximately 230 ohms d.c.

(b) Stators should read approximately 170 ohms d-c., and on a given resolver the two stators should agree within 4 ohms d.c.

(3) MOTOR. - Stators should read approximately 150 ohms d.c. per phase.

e. LUBRICATION.

(1) GEAR TRAIN.

(a) Where very low temperatures are not anticipated, a thin coating (0.005 to 0.010 inch) of ANG-25 grease (or equivalent) is recommended.

(b) If low temperatures (-30 degrees C., etc.) are anticipated, a thin film of AN-O-4 oil (or equivalent) is recommended.

(2) DIFFERENTIAL GENERATOR, SYNCHRO RESOLVER AND MOTOR. - If, during a major overhaul inspection, the ball bearings appear dry, one or two drops of AN-O-4 oil (or equivalent) properly placed should suffice.

(3) REAR CONNECTOR THREADS. - The rear connector threads should be coated lightly with a compound such as DC-4 to facilitate making connector removal.

10-5. OMNI RESOLVER ZERO USING THE 479X-2.

a. GENERAL.

(1) The 479X-2 Resolver Zeroing Panel provides a method whereby resolvers which are used in connection with omni-range service can be adjusted to give uniform results when the Omni-Bearing Selectors and Omni-Bearing Indicators using them are interchanged. The 479X-2 was devised to permit Omni-Resolver Zeroing (ORZ) procedures to be carried out with a minimum of complicated test equipment, relying principally on conventional test equipment, such as voltmeters, oscilloscopes and inexpensive audio signal generators.

(2) The latest RTCA recommendations for the zeroing of resolvers are outlined in RTCA Paper No. 209-54/DO-62, "Calibration Procedures for Test Standard Omni-Bearing Selectors and Omni-Bearing Selector Test Sets Used in the Testing of VOR Receivers and Omni-Bearing Selectors". This paper describes the latest standards and procedures for use in indexing resolvers. The 479X-2 Resolver Zeroing Panel is mentioned in this paper as a means for obtaining the necessary standard conditions for ORZ.

(3) The 479X-1, the predecessor of the 479X-2, is based on a different set of standards and can not be used to produce an ORZ in accordance with the latest RTCA paper. On the average, resolver ORZ will be off by approximately 0.3° when the 479X-1 is used. Individual resolvers may deviate from the correct ORZ by as much as 1.5°.

b. OMNI-RESOLVER ZEROING.

(1) The resolvers used in track selectors and bearing indicators associated with the airborne VHF omnidirectional range receiving equipment require a standard method of zeroing if satisfactory instrument interchangeability is to be achieved. A method of setting Electrical Zero (EZ) is prescribed in Bulletin No. 512-29D of the Eclipse - Pioneer Instrument Division of Bendix Aviation Corporation. For sine-cosine generator service in which the ratio, but not the relative phase, of the induced secondary voltages is of importance, the method cited above is very satisfactory. However, in omni-range equipment, the relative phase angle between primary (rotor) and secondary (stator) voltage is critically important, not the EZ.

(2) The method of setting EZ for resolvers as mentioned in the Eclipse-Pioneer literature will yield an ORZ which is reliable to within approximately ±1°. This applies when using the resolver identified as Collins Part No. 230 0077 00 (Eclipse-Pioneer AY-241-5-A or AY-241-5-B). With Kearfott resolvers, the error will be much greater. Manufacturing and material variations prevent the EZ from conforming with the ORZ. The difference between EZ and ORZ is the result of small variations of inductance of the primaries of different resolvers. These irregularities stem largely from variations in the permeability of the

laminations in the resolver structure and minute variations in the air gaps between rotor and stators.

(3) It is of utmost importance that the ORZ of a resolver be set under standard conditions to reduce error to a minimum. The standard conditions agreed upon are obtained with the rotor excited at 30 cps, using a 2000 ohm resistor in series with the rotor and generator. With the rotor excited as described, the induced voltage in the stator leads the generator voltage by approximately 83°. By general agreement of the members of the RTCA, this phase relation has been standardized as 83°. The 479X-2 is designed to provide these standard conditions.

(4) It having been agreed between the military (USAF) and the commercial aviation interests (ARINC) that the dials of Omni-Bearing Selectors (OBS) and Omni-Bearing Indicators (OBI) read 300° when the resolver zeroing obtains, it is necessary that a prescribed uniform phase shift through the resolver circuit be achieved. Since the resolver, as used in connection with the omnirange receivers, is a phase-shifting device, this uniform phase shift may be achieved by displacing the resolver stator windings from EZ by a slight amount, providing the dial and resolver shaft are held in a fixed position and the resolver is excited in a manner which adequately simulates the excitation system used in the receiver.

c. RESOLVER THEORY.

(1) A resolver is a sine-cosine generator used in Omni-Range receivers to produce an angular phase shift that is precisely equivalent to the angular position of its shaft. Briefly, the operation of a resolver is as described below.

(2) Refer to figure 10-14. The following discussion is based upon an "electrically perfect" resolver used in Omni-Range service. A 30 cps generator voltage (E_P) is applied to the rotor of the resolver through a 2000 ohm resistor. The current in the rotor induces voltages in the stator windings. These induced voltages are labeled E_A and E_B. The voltages E_A and E_B lead the generator voltage by approximately 83° or 83° + 180° depending upon the rotor position. The amplitudes of these voltages depend upon the angular position of the rotor. Due to the position of the windings, when E_A is fully coupled to the rotor, maximum voltage is induced at E_A and minimum voltage is induced at E_B. Omni-Bearing Selectors and Omni-Bearing Indicators are indexed so that these voltage relations occur near 300° and 120° (300°-180°). If the rotor is turned 90°, to the 210° or 30° positions, the voltage at E_B becomes maximum and the voltage at E_A becomes minimum. As the rotor is rotated, the amplitudes of voltages E_A and E_B vary regularly as the cosine and sine, respectively, of the rotor's angular position with respect to a dial reading of 300°. The phase of E_A and E_B does not vary with angular rotation of the rotor.

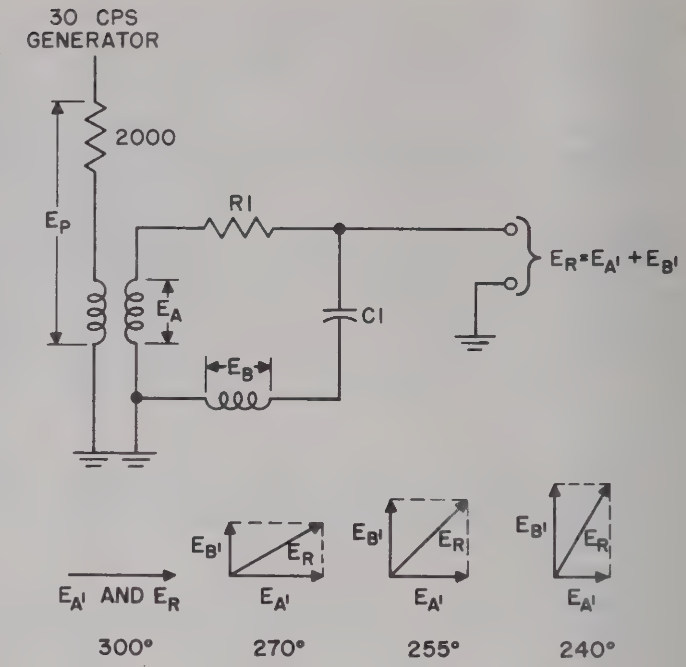


Figure 10-14. Resolver Circuit

(3) The induced voltage E_A produces a voltage at the output which will be called E_A'. The induced voltage E_B produces a voltage at the output which will be called E_B'. An RC network consisting of equal resistance and reactance (R1 and C1) is connected between the stator windings and the output. Due to the action of this RC network, voltage E_A' lags voltage E_A by 45° and voltage E_B' leads voltage E_B by 45°. Voltages E_A' and E_B' are therefore in phase quadrature.

(4) In obtaining the above relationships, the following facts are of importance: the inductance of the stator windings is very small in comparison with the resistance of R1 and the reactance of C1; and the load impedance connected across the output is considered to be infinite.

(5) These two voltages, E_A' and E_B', added vectorially, combine to produce an output that changes in phase, degree for degree, with the angular rotation of the rotor of the resolver. This

relationship is shown in figure 10-14 for resolver rotor positions of 300°, 270°, 255° and 240°.

(6) A practical resolver may not have an exact 83° relationship between the generator voltage and its stator voltage. This variation from the ideal is compensated when a resolver is indexed by the ORZ method.

d. CALIBRATION.

(1) The following calibration instructions will adjust the 479X-2 to properly set ORZ on all resolvers except Kearfott resolvers used in conjunction with both Collins 51R and competitive receivers. Customers using Kearfott resolvers with both Collins 51R and competitive receivers are urged to consult RTCA Paper No. 126-54/SC61-64 for indexing information.

(a) Connect the equipment as shown in figure 10-15. The VAR ϕ level should be approximately 1.5 volts. The REF ϕ level should be about seven volts, but can be as low as three volts (for calibration, only).

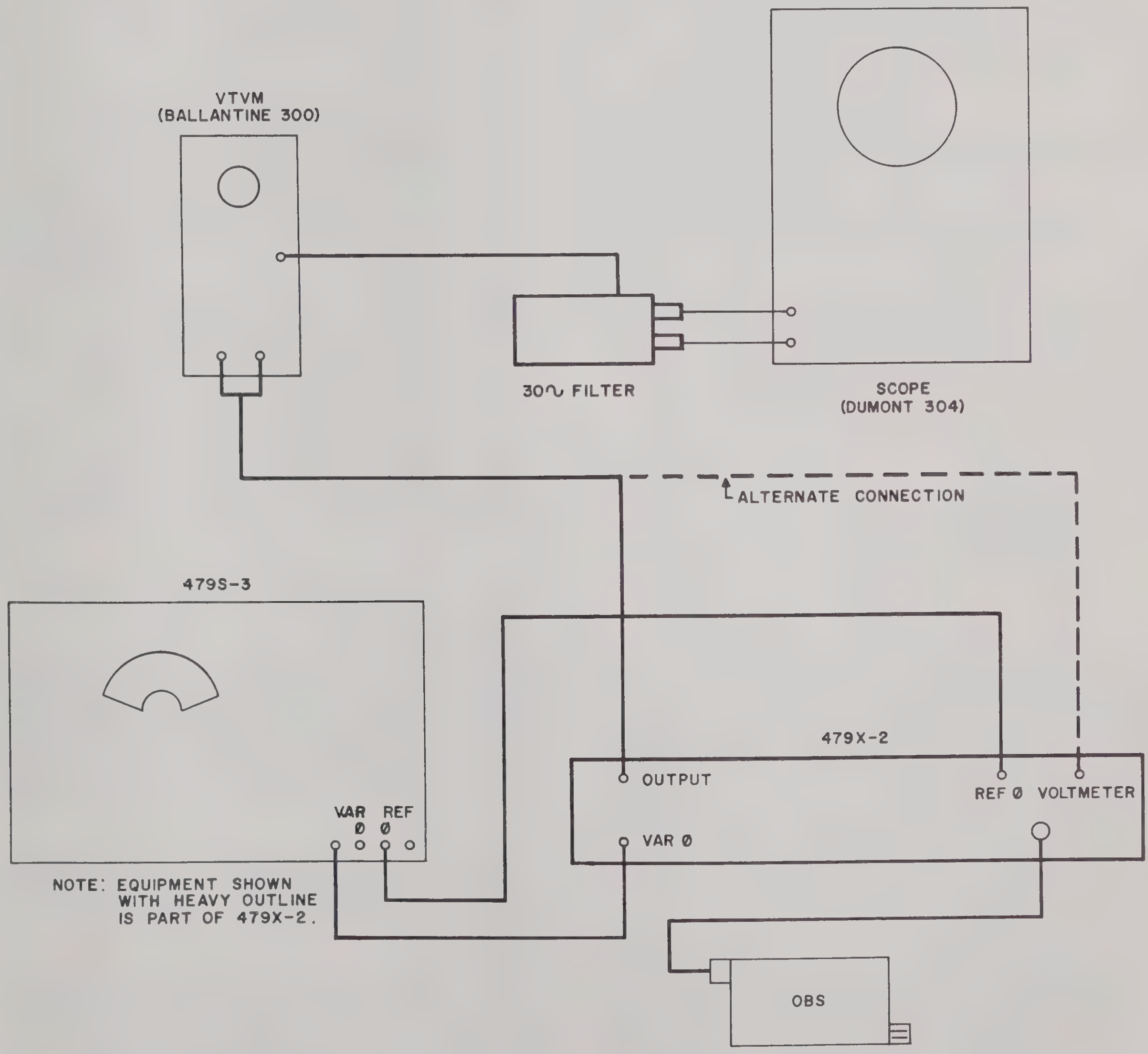

VTVM
(BALLANTINE 300)
30∿ FILTER
SCOPE
(DUMONT 304)
ALTERNATE CONNECTION
479S-3
VAR Ø
REF Ø
NOTE: EQUIPMENT SHOWN WITH HEAVY OUTLINE IS PART OF 479X-2.
479X-2
OUTPUT
REF Ø
VOLTMETER
VAR Ø
OBS

Figure 10-15. Test Setup for Calibration

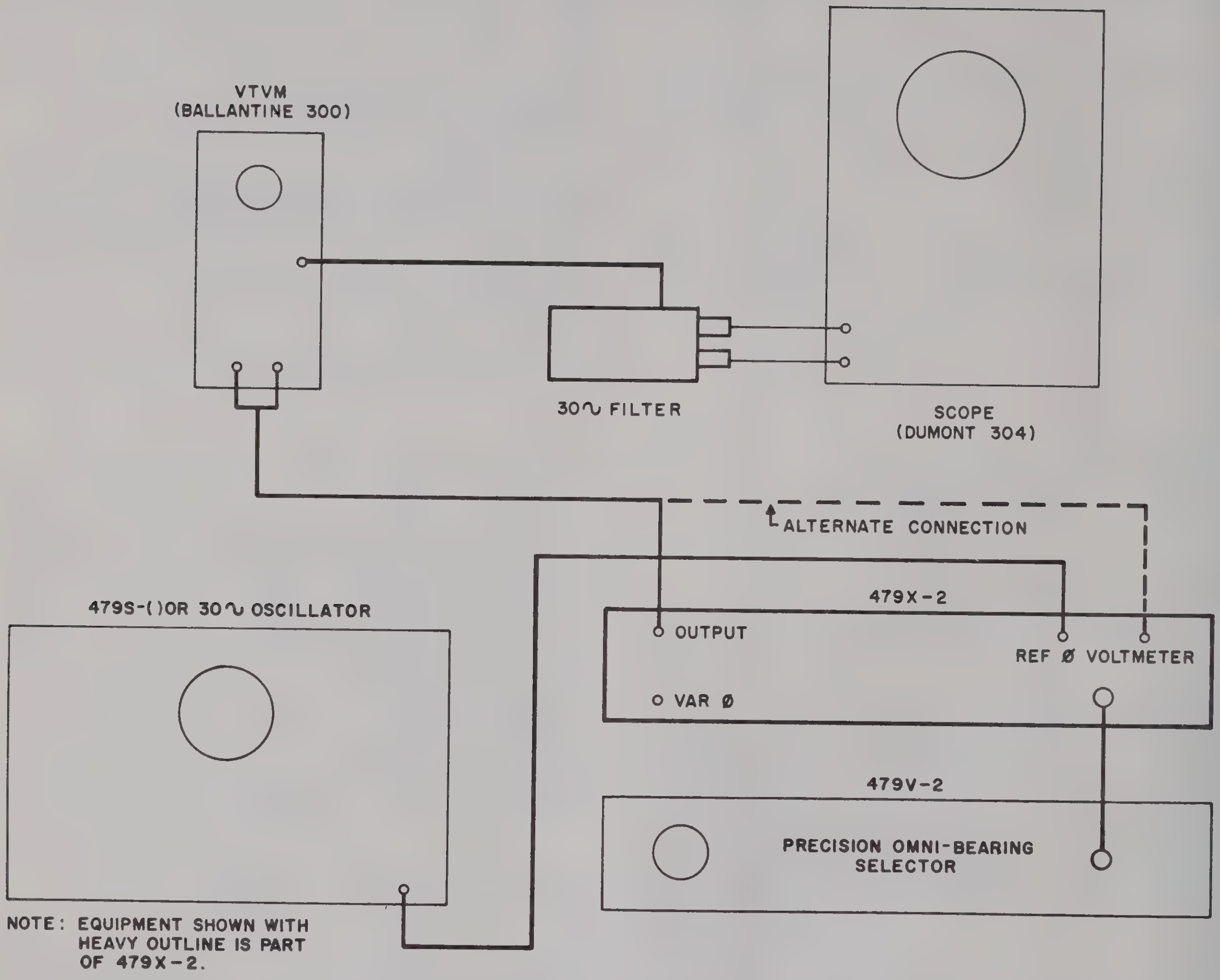

VTVM
(BALLANTINE 300)
30∿ FILTER
SCOPE
(DUMONT 304)
ALTERNATE CONNECTION
479S-( )OR 30∿ OSCILLATOR
479X-2
OUTPUT
REF Ø
VOLTMETER
VAR Ø
479V-2
PRECISION OMNI-BEARING SELECTOR
NOTE: EQUIPMENT SHOWN WITH HEAVY OUTLINE IS PART OF 479X-2.

Figure 10-16. Test Setup for ORZ

(b) Adjust the INPUT LEVEL control for a level of 4.25 volts at the VOLTMETER jack if possible. If 4.25 volts is not available a lower voltage may be used for calibration if the null detector has sufficient gain. In the process of obtaining a null in subsequent steps, it will be found advantageous to start with the gain of the VTVM relatively low, using a constant oscilloscope gain. As a null in voltage is approached, the gain of the VTVM should be appropriately increased.

(c) Turn the selector switch to CAL E and adjust the CAL E potentiometer and the VOR Audio Signal Generator phase dial for a null. This will occur near 180 degrees. Note the reading. The null detector sensitivity should be high enough to cause an appreciable indication when the VOR Audio Signal Generator phase dial is turned 0.1 degree away from a null position. When setting the VOR Audio Signal Generator phase dial for a null, approach the null in the same direction each time to minimize possible errors due to dial backlash.

(d) Turn the selector switch to CAL ϕ and set the dial for a reading 83.0 degrees less than the reading noted above.

(e) Adjust the AMP BAL control for the best null obtainable. If a good null is not obtained, reset the CAL ϕ control slightly in one direction and again adjust the AMP BAL control for a null, noting whether the null is better or not.

NOTE

Do not attempt to adjust the CAL ϕ control for a null. The proper position of the CAL ϕ control is the one that results in the best null when the AMP BAL control is adjusted.

(f) Repeat steps (c), (d) and (e) and lock the CAL ϕ control in position.

e. SETTING ORZ.

(1) The procedure for indexing an omni-bearing selector, using a 479X-2 calibrated as outlined above, is as follows:

(a) Connect the equipment as shown in figure 10-16. The 30 cycle generator can be an audio oscillator capable of delivering 4.5 to 8 volts across a 2000 ohm load or it may be a VOR Audio Signal Generator with an equivalent voltage output. The frequency of the 30 cycle source should be accurate within 1%.

(b) Set the selector switch to SET ORZ.

(c) Adjust the INPUT LEVEL control for a level of 4.25 volts at the VOLTMETER jack.

(d) Set the OBS dial to 300°.

(e) Adjust the AMP BAL control and rotate the resolver stator relative to the rotor until a null is obtained. Lock the resolver stator in place.

f. ORZ OF COLLINS EQUIPMENT.

(1) All Collins 336A-2 Omni-Bearing Selectors and 337A-2 Omni-Bearing Indicators which were manufactured after April 1, 1954 have been zeroed by use of a 479X-2 in accordance with the recommendations of RTCA Paper No. 126-54/SC61-65.

g. 331A CABLE.

(1) The Collins 331A-1 and 331A-2 Course Indicators require a special cable for use in connecting them to the 479X-2. A suitable cable may be produced by connecting the pins of a type AN 3106-28-12S and type AN 3106A-18-1S connector as outlined below.

331A Connector AN 3106-28-12S	479X-2 Connector AN 3106A-18-1S
Pin L	Pin A
M	B
P	C
N	D
R	E
S	F

Separate leads *must* be run between the pins above. Do not combine ground leads.

h. ID-249/ARN CABLE.

(1) A special cable is required to connect an ID-249/ARN to the 479X-2 for indexing. A cable may be constructed by connecting the pins of an AN 3106A-28-29S and an AN 3106A-18-1S connector as indicated below.

ID-249 Connector AN 3106A-28-29S	479X-2 Connector AN 3106A-18-1S
Pin L	Pin A
M	B
N	C
P	D
R	E
S	F

Use separate leads between each of the pins above. Do not combine ground leads.

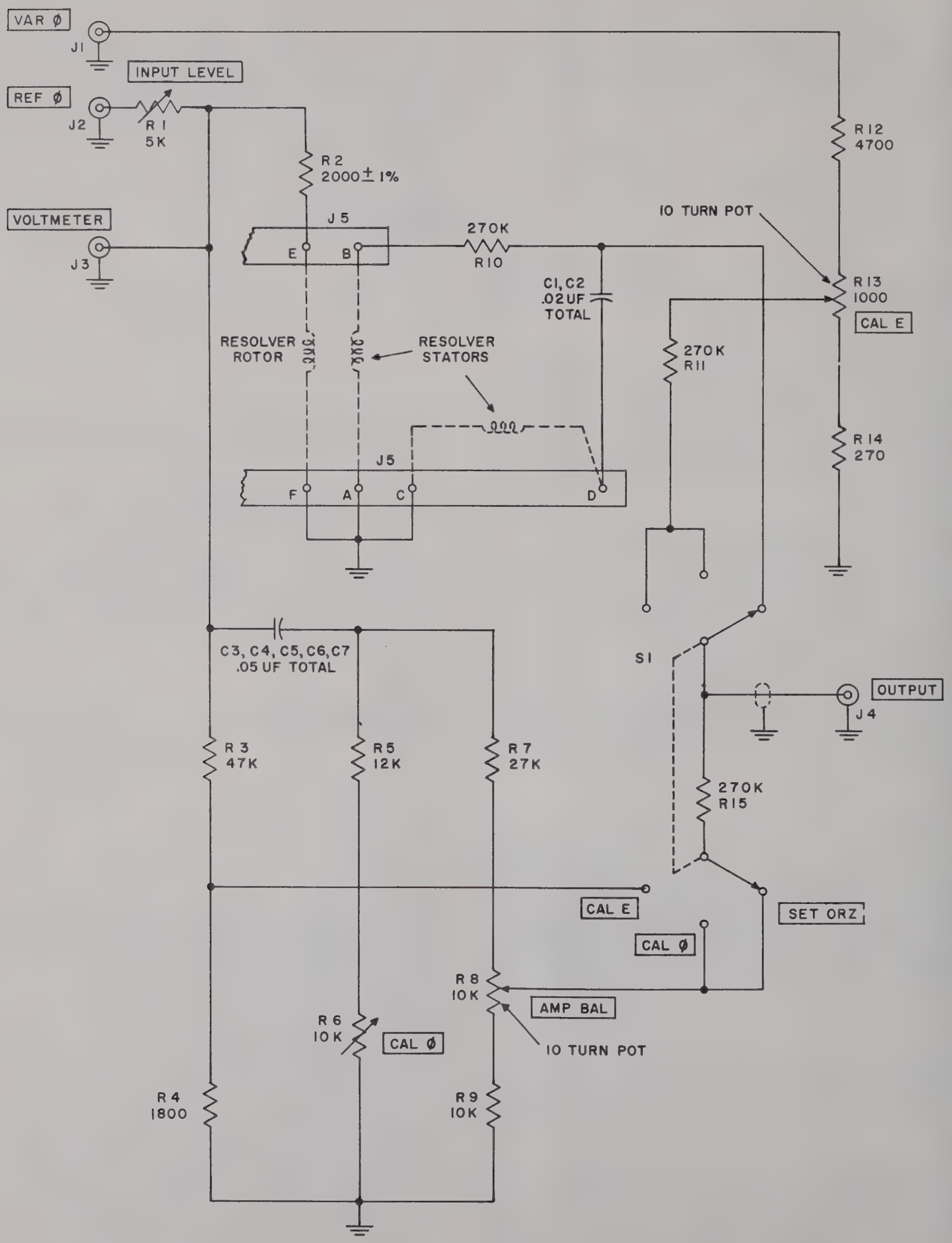

VAR Ø
J1
INPUT LEVEL
REF Ø
J2
R1
5K
R2
2000 ± 1%
VOLTMETER
J3
J5
E
B
270K
R10
10 TURN POT
R12
4700
R13
1000
CAL E
C1, C2
.02 UF
TOTAL
270K
R11
RESOLVER
ROTOR
RESOLVER
STATORS
R14
270
J5
F
A
C
D
S1
C3, C4, C5, C6, C7
.05 UF TOTAL
OUTPUT
J4
R3
47K
R5
12K
R7
27K
270K
R15
CAL E
SET ORZ
CAL Ø
R8
10K
AMP BAL
10 TURN POT
R6
10K
CAL Ø
R4
1800
R9
10K

Figure 10-17. 479X-2 Schematic

10-6. INSTRUMENT OVERHAUL PROCEDURE - 336A-1 AND 336A-2 OMNI-BEARING SELECTOR

a. DISASSEMBLY PROCEDURE.

The 336A-2 Omni-Bearing Selector may be disassembled as directed below. Disassembly should be continued only as far as necessary to facilitate repair or replacement. Refer to figure 10-9.

(1) Remove dust cover by removing 2 screws at rear of instrument.

(2) Remove 2 knobs on instrument face using #4 Bristol wrench.

(3) Remove front head by removing 8 screws on rear of instrument head.

(4) Remove glass and gasket.

(5) Remove 3 screws in escutcheon and light deflector and, very carefully, remove escutcheon. Meter pointer may have to be deflected to the "TO" position to accomplish this.

(6) Loosen 2 set screws in shutter and remove shutter.

(7) Loosen three screws in rear plate and remove rear plate leaving connector and wires attached.

(8) Remove three rear standoffs.

(9) Clip cable ties and loosen gear clamp on resolver shaft gear.

(10) Remove gear assembly as middle plate assembly is removed.

(11) Loosen resolver clamps and remove resolver from clamps.

(12) Unsolder meter wires at meter, remove meter mounting screws and remove meter.

(13) Remove 4 bearing bracket assembly mounting screws and remove dial assembly and bracket.

(14) Further disassembly, if required, will be obvious.

b. GENERAL OVERHAUL PROCEDURE.

At this point examine each component carefully to determine the requirements as to replacement or repair. A point that should be given special attention is the dial assembly trip cam and the pinion gear with which it meshes. If these items show signs of wear the following overhaul procedure should be performed on the dial assembly.

c. DIAL ASSEMBLY OVERHAUL PROCEDURE.

(1) Disassemble the dial assembly to salvage the two dials. Discard the rest of the assembly. Care is needed in disassembling this unit so that the drum dials are not damaged. Since the hub of the small dial drum is inaccessible it becomes impractical to press it from the shaft without first removing the large dial drum. This can be accomplished by drilling out the shaft of the dial shaft assembly on the cam end to the depth of the cam only. Thus the trip cam and the gear hub assembly can be removed, facilitating a simple "press removal" of the small dial drum from the shaft.

(2) The following new parts are required for the overhaul of the dial assembly.

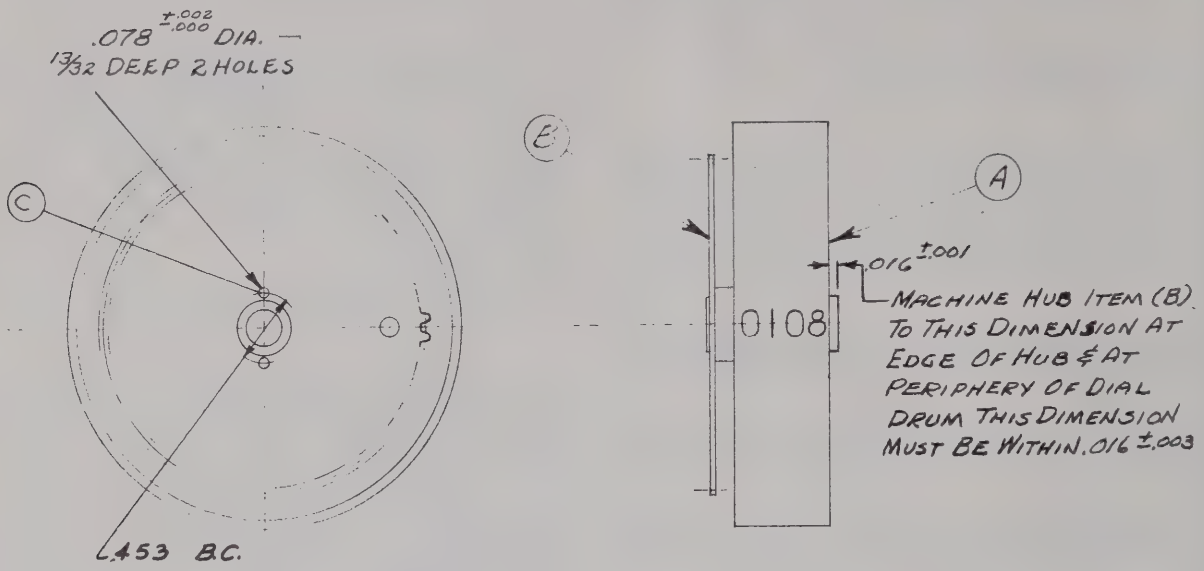
Quantity Per Unit	Description	Part No.
2	Pin, Groove	311 0004 00
1	Pinion	504 2646 001
1	Gear Hub Assy.	504 2651 001
1	Washer, Tension	504 4506 001
1	Shaft Assy. Dial	504 6564 001

(3) Reassemble the dial assembly as directed in figures 10-9, 10-18 and 10-19. Figure 10-18 explains the assembly of parts into a dial subassembly, which is assembled, in figure 10-19, into the dial assembly. Some machining may be required to complete the assembly procedure in figure 10-18.

d. OVERHAUL PROCEDURE.

Complete the overhaul of this instrument by conducting the procedure below.

(1) Check the condition of gear teeth on all gears for indications of wear or damage. Replace gears as needed.

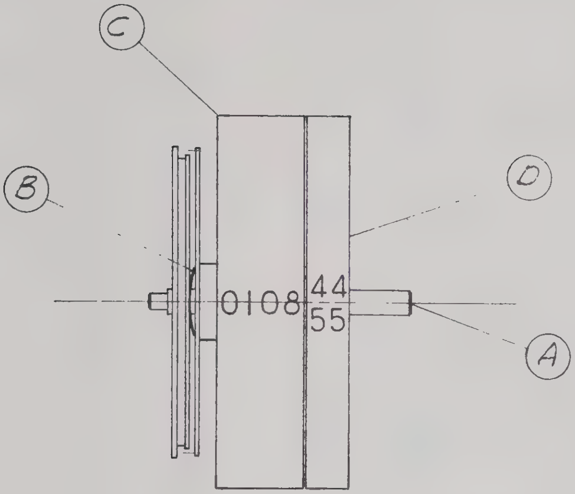

.078 +.002 -.000 DIA. —
13/32 DEEP 2 HOLES
C
E
A
.016 ±.001
MACHINE HUB ITEM (B) TO THIS DIMENSION AT EDGE OF HUB & AT PERIPHERY OF DIAL DRUM THIS DIMENSION MUST BE WITHIN .016 ±.003
0108
.453 B.C.

Item No.	Part Number	Part Name
A	503 5333 002	Large Dial Drum
B	504 2651 001	Gear Hub Ass'y
C	311 0004 00	Pin

ASSEMBLY PROCEDURE:

Press Large Dial Drum (item A) against shoulder of Gear Hub Ass'y (item B) with 1/8 diameter rod through timing holes for accurate alignment. Press in pins (item C) flush with face of gear, machine and straighten as required.

Figure 10-18. Dial Subassembly Assembling Procedure



Item No.	Part Number	Part Name
A	504 6564 001	Dial Shaft Assy
B	504 4506 001	Spring Washer
C	506 1499 003	Dial - Pinned
D	503 5332 002	Small Dial Drum

ASSEMBLY PROCEDURE:

Place spring washer (item B) on Dial Shaft Assy (item A) and Pinned Dial (item C) in position and press Small Dial Drum (item D) against shoulder on shaft with parts in position shown.

Figure 10-19. Dial Assembly Assembling Procedure

(2) Examine switch assembly for any sign of corrosion on contact surface or any evidence of discontinuity in operation. Clean or replace as needed.

(3) Check the condition of switch detent for any indication of damage or extreme wear. Replace if required.

(4) Examine the synchro resolver for the following items:

(a) Rotor electrical resistance.

(b) Stator electrical resistance.

(c) Free rotation of rotor shaft.

(d) Electrical continuity on rotor terminals while turning rotor shaft.

Resistance values and proper lubrication of synchro bearings are indicated in section 5.3.3. of the 51R-1 or 51R-2 Instruction Book, or paragraph 10-3 of this Instruction Book.

(5) Check to-from meter for freedom of pointer movement between stops. Clean meter magnet of any foreign material which may be obstructing the movement of the coil. If there is any evidence of friction in the pivots or jewels replace the meter. (Repair of the meter should be undertaken only if suitable facilities and technicians are available).

(6) Examine all soldered wire connections. Resolder if required.

c. REASSEMBLY PROCEDURE.

Reassemble as directed below. Refer to figure 10-9.

(1) Assemble 2 shim washers (500 1128 003) on small end of dial assembly.

(2) Properly time dial assembly in bearing bracket meshing gear teeth with long tooth of pinion assembly in bearing bracket.

For proper timing the center line of the cam slot and trip gear slot must be aligned with the top edge of the number 0108 on large dial drum and with a line running between the numbers 44 and 55 on the small dial drum as shown in figure 10-20. This particular gear alignment must then be meshed with the long tooth of the pinion gear.

(3) Assemble the following parts on large shaft of dial assembly.

1 washer (310 0166 00) sharp side up

1 wave washer (504 4506 001)

1 bearing bracket (504 2638 001)

(4) Reassemble bearing brackets and dial assembly on rear instrument head using four 6/32 x 3/8 Phillips fillister head screws (347 0171 00) and four lock washers (310 0077 00).

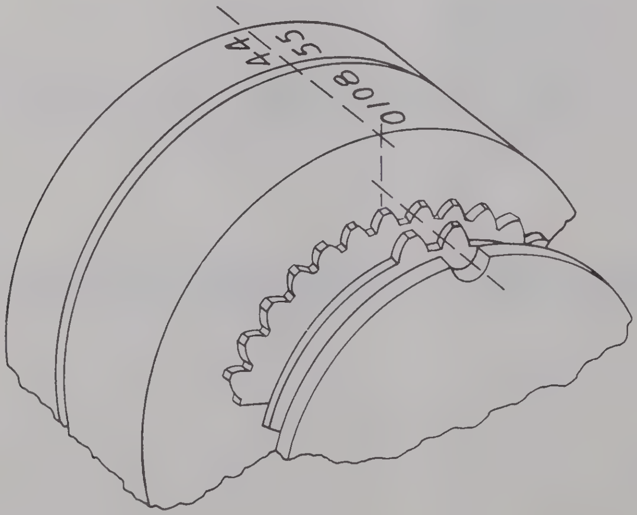


Figure 10-20. Dial Assembly Timing

(5) Assemble bevel gear (504 2657 001) on dial shaft using two 4-48 x 1/8 set screws (328 0001 00).

(6) Assemble small bevel gear (504 2658 001) and locking collar (503 5304 001) to the setting shaft assembly and insert in rear head assembly.

(7) If detent shaft assembly has been dismantled, reassemble, inserting spring (500 1189 002), ball (309 0155 00) and insert in center plate assembly. Secure shaft to center plate assembly using retaining ring (340 0090 00). Lubricate detent and ball assembly with MIL-G-3278 grease.

(8) Assemble center plate to rear head assembly by means of standoffs.

(9) Check detent shaft, setting shaft and dial assembly to make sure they turn freely. Loosen mounting screws and standoffs, adjust as necessary, and retighten.

(10) Adjust end play in shutter shaft to approx. .002 using shims (502 1145 00 and/or 502 1146 00) under retaining ring.

(11) Assemble 4-48 x 1/8 set screws (328-0001 001) in shutter assembly. Liquid stake set screws with glyptal.

(12) Assemble shutter assembly on shaft and check lateral alignment of numerals in shutter openings. If they do not line up, disassemble unit and add or subtract shims (500 1104 00) to the small end of dial shaft to get proper alignment. Shutter must clear near instrument head approx. .005 inch without scraping or binding. Tighten set screws when proper alignment is obtained.

(13) Position washers (310 0053 00), shims (500 1104 00), and dial mask in near instrument head over 2-56 tapped holes. Secure using one 2-56 x 3/8 Phillips binder head screw (343-0301 00). Liquid stake screw.

(14) Position and mount one light deflector over two bottom holes of dial mask using two 2-56 x 3/8 Phillips binder head screws (343-0301 00). Liquid stake screws.

(15) Load gear on plate assembly 2 teeth and engage pinion on shaft assembly. Secure by positioning collar against near instrument head and tighten set screws, leaving approx. .002 inch end play in shaft. Liquid stake set screws.

(16) Adjust and mesh bevel gears with a minimum of back-lash and secure by tightening set screws. Liquid stake set screws.

(17) Oil the following with MIL-L-7870 oil.

Setting shaft bearings.

Shutter shaft bearings.

Both bearings on dial assembly.

Bearings on pinion assembly.

(18) If switch stator assembly has been dismantled, reassemble using four spacers (502-1666 001), two switch segments (503 7161 001), two 4-40 x 5/8 Phillips binder head screws (343 0290 00) and two shakeproof washers (373-7010 00).

(19) If switch rotor assembly has been dismantled, reassemble two switch contacts (503-5342 001 and 503 5343 001) and one contact holder (503 5305 001).

(20) Position contact holder assembly over switch shaft using as many mica washers (302-2300 00) as necessary between the retaining ring and contact to insure proper alignment of contacts and switch.

(21) Secure assembly to the shaft using retaining ring (340 0090 00), wave washer (310-4280 00) and as many mica washers (302 2300 00) as required to produce a small tension on wave washer.

(22) Time contacts of switch rotor with switch contacts in relation to shaft detent. Tighten set screws in contact holder.

(23) Position and mount synchro resolver and loaded gear assembly on center plate (lubricate resolver case bearing surface with Alcoa thread lubricant) using two clamps (503 4752 001), two 4-40 x 5/16 Phillips fillister head screws (347-0091 00) and two lock washers (310 0076 00). Load gear assembly 2 teeth and mesh with pinion assembly before tightening clamps on resolver.

(24) Align gear teeth and tighten gear clamp.

(25) Re-tie wire ties that were removed during disassembly.

(26) Mount near plate to standoffs using three 4-40 x 5/16 Phillips binder head screws (343-0286 00) and three shakeproof washers (373-7010 00).

(27) Install "to-from" meter in instrument on mounting bracket using two 2-64 x 3/8 slotted fillister head screws (321 0193 00) and two washers (310 6230 00).

(28) Adjust meter and pointer to clean mask and so that the pointer is centered on red mark on mask. Loosen meter bracket mounting screws to make adjustment. Retighten and liquid stake mounting screws.

(29) Solder meter wires to meter terminals.

(30) Assemble escutcheon (503 5293 001), ground straps (503 7577 001), glass (192 0005 00) and gasket (302 0206 00) in front head.

(31) Mount front head assembly on instrument using eight 4-40 x 1/4 Phillips fillister head screws (347 0090 00) and eight washers (310-0076 00).

(32) Thread pilot lamp (262 0064 00) into escutcheon.

(33) Mount setting knob on shaft using set screw (328 0001 00). Liquid stake set screw.

(34) Mount shutter knob on shaft using set screw (281 0205 00). Note: Knob must clear escutcheon. Liquid stake set screw.

(35) Lubricate all gear and trip cam with a light coat of MIL-G-3278 grease.

(36) Rezero by the Omni Resolver Zero method described in section 5.3.5. of the 51R-1 and 51R-2 Instruction Book and in section 10-5 of this Instruction Book. If it is not possible to use this method set the resolver zero according to the Electrical Zero method described in section 3.3.3. of the 51R-1 and 51R-2 Instruction Book and in section 10-3 of this Instruction Book.

(37) Mount dust cover on unit using two 4-40 x 5/16 Phillips binder head screws (343 0286 00) and two shakeproof washers (373 7010 00).

10-7. INSTRUMENT OVERHAUL PROCEDURE - 337A-2 OMNI-BEARING INDICATOR.

Normally, the only maintenance requirement of the 337A-2 Omni-Bearing Indicator is the lubrication of the gear train. To lubricate the gears it is necessary to remove only the dust cover. The lubrication process is described in paragraph 10-4e of the 51R-3 Instruction Manual. If the instrument requires a more thorough overhaul, the procedure below may be used. Refer to figure 10-12.

a. DISASSEMBLY.

Disassemble the instrument as described below.

(1) Remove 2 screws on the rear of the dust cover and remove dust cover.

(2) Remove connector plate assembly from standoffs by removing 3 screws and shakeproof washers.

(3) Remove synchro resolver and synchro differential by simultaneously removing clamps on housing and loosening gear clamp assembly on shafts.

(4) Remove motor by removing 2 screws and shakeproofs from mounting flange.

(5) Remove front bead, glass and gasket by dismounting 8 screws from rear of rear instrument head.

(6) Remove mask.

(7) Withdraw dial assembly from tapered shaft.

b. OVERHAUL.

Overhaul the equipment in accordance with the following instructions.

(1) Wash gear train assembly in cleaning fluid. A solvent such as gasoline, kerosene, perchloroethylene or trichloroethylene should be used to avoid damage to paint.

CAUTION

DO NOT USE SOLVENT THAT IS A PAINT SOLVENT

(2) Oil gear shaft bearings with one drop of MIL-L-7870 Oil. Bearings should be oiled through oil wells on bearing plates.

(3) Lubricate all gear teeth with light film of MIL-G-3278 grease.

(4) If the ball bearings of the synchros and motor appear dry lubricate with one or two drops of MIL-L-7870.

c. REASSEMBLY.

Reassemble the instrument according to the steps below:

(1) Reassemble motor (230 0107 00) to bearing plate using the following parts:

2 -- #2-56 x 5/16 P.B.H. Screws (343 0125 00)

2 -- #2 Shakeproof Washers (373 8500 00)

(2) Mount synchro resolver (230 0077 00) to bearing plate and gear clamp assembly to synchro shaft simultaneously using:

1 -- Gear Clamp (503 4750 001)

1 -- #3-56 x 1/4 P.B.H. Screw (321 0187 00)

1 -- Gear Assembly (503 4759 002)

2 -- Synchro Clamps (503 4752 001)

2 -- #4-40 x 5/16 P.F.H. Screws (347 0007 00)

2 -- #4 Lock Washers (310 3340 00)

Load spring-loaded gear assembly on synchro shaft 2 teeth. Mesh with gear shaft assembly and tighten gear clamp.

(3) Mount synchro differential (230 0076 00) to bearing plate in the same manner as described for the synchro resolver in step 2 using identical parts and procedure.

(4) Reassemble connector plate assembly (504 3175 001) to standoffs using:

3 -- #4-40 x 5/16 P.B.H. Screws (343 0134 00)

3 -- #4 Shakeproof Washer (373 8010 00)

(5) Reassemble dial assembly (503 4743 001) onto dial shaft. Lightly tap or press hub flush with end of shaft.

(6) Reassemble mask, gasket, glass and front instrument head to rear instrument head using:

8 -- #4-40 x 1/4 P.F.H. Screws (347 0006 00)

8 -- #4 Lockwashers (310 3340 00)

1 -- Mask (503 4754 002)

1 -- Gasket (302 0206 00)

1 -- Glass (102 1003 00)

1 -- Front Instrument Head (503 4760 003)

Locating tab in mask must line up with slot in rear instrument head.

(7) Zero the two synchros as outlined in paragraph 10-4 of the 51R-3 Instruction Manual.

(8) Replace dust cover using:

2 -- #4-40 x 5/16 P.B.H. Screws (343 0134 00)

2 -- #4 Shakeproof washers (373 8010 00)

1 -- Dust Cover (503 4755 002)

SECTION 11

PARTS LIST

Since publication of the first 51R-3 Instruction Manual, it has been found desirable to make several changes to the receiver to provide improved performance and longer equipment life. These changes are described below.

1. In all receivers with serial numbers of 1310 or greater, and in some scattered numbers below 1310, resistors R130 and R131 were increased in rating to 2 watts to provide additional safety margin. The part number of the 2 watt resistor is 745 9136 00. The description and part number of R130 and R131 should be changed.

2. All receivers of serial number 1852 and above, and some scattered numbers below 1852, use a type IN81 crystal (Collins part number 353 0129 00) for CR105. Reference is made to this component in the parts list and in figure 12-1. The change to a type IN81 was made because the type IN54A was not readily available. The type IN54A installed in some units will provide satisfactory performance.

3. Effective with all receivers of serial number 1696 and above, and some scattered numbers below 1696, the input transformers T113 and T116 were changed to a part number 673 0281 00 because of the relative inavailability of part number 677 0476 00 previously used. Main schematic diagrams, modified for use with receiver serial numbers 1696 and above is included in this book.

   The terminal arrangement of transformer 673 0281 00 differs from the terminal arrangement of transformers previously used. The terminal arrangement of 673 0281 00 (T113 and T116) is shown on the wiring diagrams.

4. Effective with serial number 1591 and above, and some scattered numbers below 1691, the cathode of V118B was partially bypassed to increase the maximum reference channel output obtainable. To compensate for the increase in reference signal in the automatic channel, the value of resistor R210 was changed. The cathode bypass circuit, consisting of C165 and R188, and the modified value of R210 are shown on the schematic. The modification also appears on the wiring diagrams.

DYNAMOTOR PARTS

The part number of the preferred dynamotor D-301 is 231 0177 00. Replaceable parts for this dynamotor are listed below:

Description	Quantity	Part Number
BRUSH, INPUT, +	(1)	234 0538 00
BRUSH, INPUT, -	(1)	234 0539 00
BRUSH, OUTPUT, +	(1)	234 0540 00
BRUSH, OUTPUT, -	(1)	234 0541 00
BRUSH HOLDER, INPUT	(2)	234 0542 00
BRUSH HOLDER, OUTPUT	(2)	234 0543 00
CAP, BRUSH HOLDER	(4)	234 0544 00
BEARINGS	(2)	234 0545 00
ROTOR ASSEMBLY	(1)	234 0546 00
FIELD COIL (SET)	(1)	234 0547 00
IMPELLER	(1)	234 0548 00
CAPACITOR, INPUT	(1)	234 0549 00
CAPACITOR, OUTPUT	(1)	234 0550 00
SHIM WASHERS	As req'd	234 0551 00 234 0552 00 234 0553 00
END BELL, INPUT	(1)	234 0554 00
END BELL, OUTPUT	(1)	234 0555 00
OIL SLINGER	(2)	234 0556 00
GASKET	(2)	234 0557 00
BOLT	(2)	234 0558 00

The part number of the alternate dynamotor D-301 is 231 0036 00. The replaceable parts listed in the parts list are for this alternate dynamotor.

MODIFIED 416N-4 AND 416N-5 POWER SUPPLIES

The parts list for the modified power supplies (if used) is amended. In addition to the parts listed in the parts list, the modified 416N-4 and 416N-5 power supplies each use the parts listed below.

ITEM	FUNCTION	DESCRIPTION	PART NO.
K301	Relay	RELAY: Armature, 26.5 v, 480 ohm p/m 10%	972 1278 00
R301	Bleeder	RESISTOR: 1 megohm p/m 10%, 1 w	745 3212 00

The modified 416N-4 and 416N-5 power supply schematic diagrams are figures 12-20 and 12-21.

51R-3 505 4067 005

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
B101	Autopositioner	MOTOR: DC, 250 rpm full load	505 3973 003
C101	R-F Amp grid tuning	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C102	R-F Amp grid tuning	CAPACITOR: Ceramic, 3.0 mmf p/m 1/2 mmf, 500 WV	928 4377 00
C103	R-F Amp AVC Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C104	R-F Amp Grid Coupling	CAPACITOR: Ceramic, 7.0 mmf p/m 1/2 mmf, 500 WV	928 4393 00
C105	Crystal Coupling	CAPACITOR: Mica 47. mmf p/m 10%, 500 WV	912 0471 00
C106	R-F Amp Cathode Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0937 00
C107	R-F Amp Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C108	R-F Amp Screen Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C109	R-F Amp Plate Trimmer	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C110	R-F Amp Plate Tuning	CAPACITOR: Ceramic, 3.0 mmf p/m 1/2 mmf, 500 WV	928 4377 00
C111	R-F Amp Plate Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C112	Screen B+ Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C113	R-F Amp B+ Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C114	1st Mixer Grid Tuning	CAPACITOR: Ceramic, 5.0 mmf p/m 1/2 mmf, 500 WV	928 4385 00

p/m = plus or minus (±)

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C115	1st Mixer Grid Tuning	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C116	1st Mixer Grid Coupling	CAPACITOR: Ceramic, 3.0 mmf p/m 1/2 mmf, 500 WV	928 4377 00
C117	R-F B+ Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C118	HF Osc Coupling	CAPACITOR: Ceramic, 2.0 mmf p/m 1/4 mmf, 500 WV	928 4373 00
C119	1st Mixer Screen Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C120	1st Mixer Screen Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C121	1st Mixer Plate Coupling	CAPACITOR: Mica, 100 mmf p/m 10%, 500 WV	912 0495 00
C122	Var I-F Grid Coupling	CAPACITOR: Ceramic, 10 mmf p/m 1 mmf, 500 WV	928 4406 00
C123	Var I-F Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C124	Var I-F Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C125	Var I-F Plate Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C126	2nd Mixer Grid Coupling	CAPACITOR: Ceramic, 24 mmf p/m 10%, 500 WV	928 4328 00
C127	2nd Mixer Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C128	LF Osc Coupling	CAPACITOR: Ceramic, 5.0 mmf p/m 1 mmf, 500 WV	928 4386 00
C129	2nd Mixer Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C130	1st I-F Grid Coupling	CAPACITOR: Ceramic, 5.0 mmf p/m 1/2 mmf, 500 WV	928 4385 00
C131	RF Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C132	1st I-F Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C133	1st I-F Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C134	2nd I-F Grid Coupling	CAPACITOR: Ceramic, 10 mmf p/m 1 mmf, 500 WV	928 4406 00
C135	2nd I-F Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C136	2nd I-F Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C137	3rd I-F Cathode Bypass	CAPACITOR: Paper, 10,000 mmf p/m 10%, 200 WV at 85°C	931 0321 00
C138	B+ Filter	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C139	HF Osc Feed Back	CAPACITOR: Mica, 390 mmf p/m 10%, 500 WV	912 0537 00
C140	HF Osc Trimmer	CAPACITOR: Variable, ceramic 2 to 7 mmf	917 1013 00
C141	HF Osc Tuning	CAPACITOR: Ceramic, 12 mmf p/m 5%, 500 WV	928 0242 00
C142	HF Osc Mult. Grid Tuning	CAPACITOR: Ceramic, 10 mmf p/m 1 mmf, 500 WV	928 4406 00
C143	HF Osc Mult. Grid Trimmer	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C144	H-F Osc Plate Filter	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C145	H-F Osc B+ Filter	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C146	H-F Inj Amp. Grid Coupling	CAPACITOR: Ceramic, 5.0 mmf p/m 1/2 mmf, 500 WV	928 4385 00
C147	H-F Inj Amp. Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C148	H-F Inj Amp. Screen Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0937 00
C149	H-F Inj Amp. Plate Trimmer	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C150	H-F Inj Amp. Plate Tuning	CAPACITOR: Ceramic, 7.0 mmf, p/m 1/2 mmf, 500 WV	928 4393 00
C151	H-F Inj Amp. Plate Filter	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C152	H-F Inj Amp B+ Filter	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C153	H-F Inj Amp. Tuning	CAPACITOR: Ceramic, 10 mmf p/m 1 mmf, 500 WV	928 4406 00
C154	H-F Inj Amp. Trimmer	CAPACITOR: Variable, 0.8 to 7.0 mmf, 500 WV	917 1053 00
C155	LF Osc B+ Filter	CAPACITOR: Mica, 8200 mmf p/m 10%, 500 WV	935 3079 00
C156	LF Osc B+ Filter	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C157	LF Osc Plate Coupling	CAPACITOR: Ceramic, 10 mmf p/m 1 mmf, 500 WV	928 4406 00
C158	LF Osc Screen Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C159	LF Osc Grid	CAPACITOR: Ceramic, 20 mmf p/m 2%, 500 WV	928 4054 00
C160	LF Osc Grid	CAPACITOR: Mica, 220 mmf p/m 10%, 500 WV	912 0519 00
C161	Detector Output Filter	CAPACITOR: Mica, 100 mmf p/m 10%, 500 WV	912 0495 00
C162	Audio Bypass	CAPACITOR: Paper, 0.5 mf p/m 20% ea sect, 100 WV	962 9006 00
C163	Detector Cathode Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C164	Squelch Grid	CAPACITOR: Paper, .1 mf p/m 10%, 150 WV	931 0333 00
C165	Bypass	CAPACITOR: Paper, .1 mf p/m 10%, 150 WV	931 0333 00
C166	Audio Bypass	CAPACITOR: Paper, 0.5 mf p/m 20% ea sect, 100 WV	962 9006 00
C167	1st Audio Plate Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C168	Noise Limiter Filter	CAPACITOR: Mica, 470 mmf p/m 10%, 300 WV	912 0543 00
C169	1st Audio Coupling	CAPACITOR: Paper, 10,000 mmf p/m 10%, 200 WV at 85°C	931 0321 00
C170	Noise Limiter Filter	CAPACITOR: Paper, .1 mf p/m 10%, 150 WV	931 0333 00
C171	Noise Limiter Coupling	CAPACITOR: Paper, 10,000 mmf p/m 10%, 200 WV at 85°C	931 0321 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C172	Audio Filter	CAPACITOR: Paper, 0.0047 mf p/m 20%, 300 WV	931 0358 00
C173	Ref. Amp. Grid Coupling	CAPACITOR: Mica, 1,000 mmf p/m 2%, 300 WV	935 5012 00
C174	1st Limiter Grid Coupling	CAPACITOR: Mica, 390 mmf p/m 10% 500 WV	912 0537 00
C175	2nd Limiter Grid Coupling	CAPACITOR: Mica, 390 mmf p/m 10%, 500 WV	912 0537 00
C176	Trans. Amp. Grid Coupling	CAPACITOR: Mica, 1000 mmf p/m 2%, 300 WV	935 5012 00
C177	FM Det Tuning	CAPACITOR: Mica, 1100 mmf p/m 2%, 300 WV	935 5013 00
C178	FM Det Tuning	CAPACITOR: Mica, 56 mmf p/m 10%, 500 WV	912 0477 00
C179	Ref. Channel Det Load Filter	CAPACITOR: Mica, 5600 mmf p/m 2%, 500 WV	935 2375 00
C180	Man. Resolver CF Grid	CAPACITOR: Paper, .25 mf p/m 10%, 400 WV	930 0214 00
C181	Auto Resolver CF Grid	CAPACITOR: Paper, .25 mf p/m 10%, 400 WV	930 0214 00
C182	Ref. Amp. Coupling	CAPACITOR: Paper, .25 mf p/m 10%, 400 WV	930 0214 00
C183	Ref. Amp Coupling	CAPACITOR: Paper, .25 mf p/m 10%, 400 WV	930 0214 00
C184	Ref. Amp. B+ Filter	CAPACITOR: Paper, 1.0 mf p/m 10%, 600 WV	930 0204 00
C185	Var. Channel Coupling	CAPACITOR: Paper, 0.5 mf p/m 10%, 400 WV	930 0184 00
C186	Plate Decoupling	CAPACITOR: Paper, 0.5 mf p/m 20% ea sect, 400 WV	962 9049 00
C187	Z-103 Filter Tuning	CAPACITOR ASSEMBLY: 0.048 mf p/m 2%, 2000 mmf p/m 5%, 0.05 mf p/m 2%	504 9295 003
C188	Var Amp. Coupling	CAPACITOR: Mica, .25 mf p/m 10%, 400 WV	930 0214 00
C189	Var Amp. Coupling	CAPACITOR: Mica, .25 mf p/m 10%, 400 WV	930 0214 00
C190	Auto Amp. Coupling	CAPACITOR: Mica, .25 mf p/m 10%, 400 WV	930 0214 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C191	Auto Amp. Coupling	CAPACITOR: Mica, .25 mf p/m 10%, 400 WV	930 0214 00
C192	Auto Coupling	CAPACITOR: Paper, .05 mf p/m 10%, 400 WV	930 0216 00
C193	Auto Coupling	CAPACITOR: Paper, .05 mf p/m 10%, 400 WV	930 0216 00
C194	Auto Reactor Control Cathode Bypass	CAPACITOR: Electrolytic, 25 mf, 100 WV	184 6525 00
C195	Regulator Circuit	CAPACITOR: Paper, 33,000 mmf p/m 20%, 400 WV	931 0458 00
C196	Auto Injection Plate Filter	CAPACITOR: Mica, 390 mmf p/m 10%, 500 WV	912 0537 00
C197	Reactor Primary Shunt	CAPACITOR: Paper, 1.7 mf p/m 15%, 100 WV	962 9022 00
C198	Reactor Primary Shunt	CAPACITOR: Paper, 1.7 mf p/m 15%, 100 WV	962 9022 00
C199	Motor Control	CAPACITOR: Paper, 1.7 mf p/m 15%, 100 WV	962 9022 00
C200	To-From Phase Splitting	CAPACITOR: Paper, 1.0 mf p/m 10%, 100 WV	961 4276 00
C201	Filament Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C202	Filament Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C203	Filament Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C204	Filament Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C205	Filament Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C206	Filament Bypass	CAPACITOR: Ceramic, 2000 mmf p/m 20%, 500 WV	913 0871 00
C207	Filament Filter	CAPACITOR: Mica, 8200 mmf p/m 10%, 500 WV	935 3079 00
C208	A+ Filter	CAPACITOR: Paper, .2 mf p/m 10%, 120 WV	931 0151 00
C209	B+ Bypass	CAPACITOR: Paper, 10,000 mmf p/m 20%, 400 WV	931 0455 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C210	Filament Bypass	CAPACITOR: Paper, .1 mf p/m 10%, 150 WV	931 0333 00
C211	B+ Blocking	CAPACITOR: Paper .5 p/m 10%, 400 WV	930 0184 00
C212	Phasing	CAPACITOR: Mica 2,000 mmf, p/m 5%, 500 WV	935 2162 00
C213	R-F Bypass	CAPACITOR: Mica, 500 mmf p/m 20%, 500 WV	912 0667 00
C215	Stabilizer	CAPACITOR: Mica, 220 mmf p/m 10%, 500 WV	912 0519 00
CR101	Ref. Channel Det.	RECTIFIER ASSEMBLY: Inverse peak v rating 180 v	353 0102 00
CR102	Phase Comparator	CRYSTAL UNIT: Rectifying, 4.5 v	353 0104 00
CR103	To-From Det.	CRYSTAL UNIT: Rectifying, 75 peak inverse v	353 0103 00
CR104	To-From Det.	CRYSTAL UNIT: Rectifying, 75 peak inverse v	353 0103 00
CR105	Limiter	CRYSTAL UNIT: Rectifying, type IN-81	353 0129 00
I101	Pulse Limiter	LAMP: Glow, 90 v DC, 1/25 w	262 0265 00
I102	Pulse Limiter	LAMP: Glow, 90 v DC, 1/25 w	262 0265 00
J101	R.F. Input	CONNECTOR: Receptacle, single female cont	357 9003 00
J501		CONNECTOR: 45 female contacts, mtd on rec. shockmtg	370 2034 00
K101	Megacycle Auto-positioner	RELAY: Armature, SPST, 10 amp, 26.5 v DC	504 8682 004
K102	Tenth Megacycle Autopositioner	RELAY: Armature, SPDT, 10 amp, 26.5 v DC	410 0083 00
K103	Autopositioner Control	RELAY: Armature, 26.5 v, 280 ohm p/m 20%	974 0090 00
K104		Not used	
K105	VOR/LOC Switching	RELAY: Rotary, 26.5 v, 7.5 ohm p/m 10%	410 0077 00
L101	HF Osc Cathode	COIL, RF: 23 turns #30 AWG wire	505 1474 002
L102	HF Osc Plate	COIL, RF: #22 AWG wire	504 9305 002
L103	HF Osc Cathode	COIL, RF: 19 turns #30 AWG E wire on 220 ohm Resistor	505 1475 002
L104	LF Osc Cathode	COIL, RF: .5 mh, 112 turns #36 nylon E wire ea pie	505 1487 001
L105	Filament Filter	COIL, RF: 20 turns #24 AWG E wire	505 1473 002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
L106	Filament Filter	COIL, RF: 5.6 uh, 36 turns #24 AWG E wire	504 5136 002
L107	Filament Filter	COIL, RF: 5.6 uh, 36 turns #24 AWG E wire	504 5136 002
L108	Filament Filter	COIL, RF: 30 turns SE litz wire on ea sect	504 9346 001
L109	Filament Filter	COIL, RF: 30 turns SE litz wire on ea sect	504 9346 001
L110	HF Osc Cathode	COIL, RF: 19 turns #30 AWG E wire on 220 ohm Resistor	505 1475 002
P101	Receiver Connector	CONNECTOR: Plug, 45 round male pol cont	370 2033 00
R101	RF Amp Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R102	RF Amp Cathode	RESISTOR: 220 ohm p/m 10%, 1/2 w	745 1058 00
R103		Not used	
R104	RF Amp Screen	RESISTOR: 2200 ohm p/m 10%, 1/2 w	745 1100 00
R105	RF Amp Screen	RESISTOR: 8200 ohm p/m 10%, 1/2 w	745 1125 00
R106	RF Amp Plate	RESISTOR: 10,000 ohm p/m 10%, 1/2 w	745 1128 00
R107	1st Mixer Grid	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R108	B+ Dropping	RESISTOR: 220 ohm p/m 10%, 1/2 w	745 1058 00
R109	B+ Dropping	RESISTOR: 220 ohm p/m 10%, 1/2 w	745 1058 00
R110	1st Mixer Screen	RESISTOR: 1.0 meg p/m 10%, 1/2 w	745 1212 00
R111	1st Mixer Plate	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R112	VAR IF Amp Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R113	VAR IF Amp Cathode	RESISTOR: 1,000 ohm p/m 10%, 1/2 w	745 1086 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R114	VAR IF Amp Screen	RESISTOR: 3300 ohm p/m 10%, 1/2 w	745 1107 00
R115	VAR IF Amp Plate	RESISTOR: 33,000 ohm p/m 10%, 1/2 w	745 1149 00
R116	2nd Mixer Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R117	2nd Mixer Cathode	RESISTOR: 1500 ohm p/m 10%, 1/2 w	745 1093 00
R118	2nd Mixer Screen	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R119	1st FIF Grid	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R120	1st FIF Cathode	RESISTOR: 2700 ohm p/m 10%, 1/2 w	745 1104 00
R121	2nd FIF Grid	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R122	2nd FIF Cathode	RESISTOR: 1500 ohm p/m 10%, 1/2 w	745 1093 00
R123	RF Screen Voltage Dropping	RESISTOR: 6800 ohm p/m 10%, 1/2 w	745 1121 00
R124	3rd FIF Cathode	RESISTOR: 1200 ohm p/m 10%, 1/2 w	745 1090 00
R125	Current Limiting	RESISTOR: 4,000 ohm p/m 5%, 4 w	747 9032 00
R126	Remote Squelch Shunt	RESISTOR: 5600 ohm p/m 10%, 1/2 w	745 1118 00
R127	B+ Dropping	RESISTOR: 2200 ohm p/m 10%, 2 w	745 9111 00
R128	HF Osc Par. Sup.	RESISTOR: 68 ohm p/m 10%, 1/2 w	745 1037 00
R129	HF Osc Grid	RESISTOR: 4700 ohm p/m 10%, 1/2 w	745 1114 00
R130	HF Osc Plate	RESISTOR: 8200 ohm p/m 10%, 1 w	745 3125 00
R131	HF Osc Plate	RESISTOR: 8200 ohm p/m 10%, 1 w	745 3125 00
R132	HF Inj Amp Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R133	HF Inj Amp Screen	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R134	HF Inj Amp Cathode	RESISTOR: 390 ohm p/m 10%, 1/2 w	745 1069 00
R135	HF Inj Amp Plate	RESISTOR: 33,000 ohm p/m 10%, 1/2 w	745 1149 00
R136	B+ Dropping	RESISTOR: 220 ohm p/m 10%, 1/2 w	745 1058 00
R137	LF Osc Screen	RESISTOR: 4700 ohm p/m 10%, 1/2 w	745 1114 00
R138	LF Osc Plate	RESISTOR: 18,000 ohm p/m 10%, 1/2 w	745 1139 00
R139	LF Osc Screen	RESISTOR: 47,000 ohm p/m 10%, 1/2 w	745 1156 00
R140	LF Osc Cathode	RESISTOR: 150 ohm p/m 10%, 1/2 w	745 1051 00
R141	LF Osc Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R142	Detector Load	RESISTOR: 100,000 ohm p/m 20%, 2 w (Variable)	380 0322 00
R143	Detector Cathode	RESISTOR: 6800 ohm p/m 5%, 1/2 w	745 1120 00
R144	Detector Cathode Voltage Divider	RESISTOR: 6800 ohm p/m 5%, 1/2 w	745 1162 00
R145	AVC Load	RESISTOR: 220,000 ohm p/m 10 %, 1/2 w	745 1184 00
R146	AVC Filter	RESISTOR: 330,000 ohm p/m 10%, 1/2 w	745 1191 00
R147	AVC Filter	RESISTOR: 330,000 ohm p/m 10%, 1/2 w	745 1191 00
R148	Noise Limiter Grid	RESISTOR: 1.0 meg p/m 10%, 1/2 w	745 1212 00
R149	1st AF Amp Cathode	RESISTOR: 820 ohm p/m 10%, 1/2 w	745 1083 00
R150	Squelch Threshold Level	RESISTOR: 2500 ohm p/m 20%, 2 w (Variable)	380 0313 00
R151	Squelch Limiting	RESISTOR: 15,000 ohm p/m 5%, 1/2 w	745 1134 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R152	1st AF amp Plate	RESISTOR: 47,000 ohm p/m 10%, 1/2 w	745 1156 00
R153	Squelch Bias Voltage Divider	RESISTOR: 47,000 ohm p/m 5%, 1/2 w	745 1155 00
R154	1st AF Amp Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R155	Squelch Limiting	RESISTOR: 1800 ohm p/m 5%, 1/2 w	745 1096 00
R156	Aural Level	RESISTOR: 50,000 ohm p/m 20%, 1 w (Variable)	376 0056 00
R157	VOR Zero Extending	RESISTOR: 10,000 ohm p/m 3%, 5 w	747 9410 00
R158	AF Signal Dropping	RESISTOR: 27,000 ohm p/m 10%, 1/2 w	745 1146 00
R159	AF Output Cathode	RESISTOR: 820 ohm p/m 10%, 1/2 w	745 1083 00
R160	Noise Limiter Cathode	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R161	Noise Limiter Plate	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R162	Noise Limiter Cathode	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R163	Ref. Channel Filter	RESISTOR: 82,000 ohm p/m 10%, 1/2 w	745 1167 00
R164	Ref. Amp. Grid	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R165	Ref. Amp. Cathode	RESISTOR: 1,000 ohm p/m 10%, 1/2 w	745 1086 00
R166	Ref. Amp. Plate	RESISTOR: 56,000 ohm p/m 10%, 1/2 w	745 1160 00
R167	1st Limiter Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R168	1st Limiter Cathode	RESISTOR: 6800 ohm p/m 10%, 1/2 w	745 1121 00
R169	1st Limiter Plate	RESISTOR: 56,000 ohm p/m 10%, 1/2 w	745 1160 00
R170	2nd Limiter Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2w	745 1198 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R171	2nd Limiter Cathode	RESISTOR: 6800 ohm p/m 5%, 1/2 w	745 1120 00
R172	2nd Limiter Plate	RESISTOR: 56,000 ohm p/m 10%, 1/2 w	745 1160 00
R173	Part of Anti-Resonant Filter	RESISTOR: 27,000 ohm p/m 10%, 1/2 w	745 1146 00
R174	Translater Amp Cathode	RESISTOR: 1,000 ohm p/m 10%, 1/2 w	745 1086 00
R175	Ref. Channel Rectifier Load	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R176	Auto Cathode Follower Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R177	Manual Cathode Follower Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2w	745 1198 00
R178	Manual CF Cathode	RESISTOR: 1500 ohm p/m 5%, 1 w	708 0115 00
R179	Auto CF Cathode	RESISTOR: 1500 ohm p/m 5%, 1 w	708 0115 00
R180	Manual Tracking	RESISTOR: 25,000 ohm p/m 20% 2 w (Variable)	380 0321 00
R181	Ref. Level	RESISTOR: 500,000 ohm p/m 20% 2 w (Variable)	380 0328 00
R182	AVC Filter	RESISTOR: 47,000 ohm p/m 10%, 1/2 w	745 1156 00
R183	Ref. Phase Amp. Decoupling	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R184	Ref. Phase Amp. Cathode	RESISTOR: 3300 ohm p/m 10%, 1/2 w	745 1107 00
R185	Ref. Phase Amp Grid	RESISTOR: 3300 ohm p/m 10% 1/2 w	745 1107 00
R186	Ref. Phase Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R187	Ref. Phase Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R188	Bypass Control	RESISTOR: 1000 ohm p/m 10%, 1/2 w	745 1086 00
R189	Ref. Amp Feedback	RESISTOR: 1.5 meg p/m 10%, 1/2 w	745 1219 00
R190	Ref. Channel Frequency Compensation	RESISTOR: .22 megohm p/m 5%, 1/2 w	745 1183 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R191	Ref. Channel Output Cathode	RESISTOR: 680 ohm p/m 10%, 1/2 w	745 1079 00
R192	AVC Decoupling Filter	RESISTOR: 330,000 ohm p/m 10%, 1/2 w	745 1191 00
R193	LOC Sens. Limiter	RESISTOR: 33,000 ohm p/m 10%, 1/2 w	745 1149 00
R194	LOC Sensitivity	RESISTOR: 100,000 ohm p/m 20%	380 0322 00
R195	Var. Channel Input	RESISTOR: .39 meg p/m 5%, 1/2 w	745 1194 00
R196	Var Channel Filter Input	RESISTOR: 330,000 ohm p/m 1%, 0.1 w	748 0051 00
R197	Z103 Swamping	RESISTOR: 56,000 ohm p/m 10%, 1/2 w	745 1160 00
R198	VOR Zero	RESISTOR: 10,000 ohm p/m 10%, 2 w (Variable)	750 8061 00
R199	Var Phase Amp Cathode	RESISTOR: 1500 ohm p/m 10%, 1/2 w	745 1093 00
R200	Var Phase Amp Plate Decoupling	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R201	Var Phase Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R202	Var Phase Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R203	Var Phase Output Grid-Voltage Divider	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R204	Var Phase Amp Grid	RESISTOR: 39,000 ohm p/m 5%, 1/2 w	745 1152 00
R205	Var Phase Output Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R206	Var Phase Output Cathode	RESISTOR: 680 ohm p/m 10%, 1/2 w	745 1079 00
R207	Auto Tracking	RESISTOR: 25,000 ohm p/m 20%, 2 w (Variable)	380 0321 00
R208	Auto Amp Cathode	RESISTOR: 3300 ohm p/m 10%, 1/2 w	745 1107 00
R209	Auto Amp Cathode	RESISTOR: 3300 ohm p/m 10%, 1/2 w	745 1107 00
R210	Auto Amp Feedback	RESISTOR: .68 meg p/m 10%, 1/2 w	745 1205 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R211	Auto Amp Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R212	Auto Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R213	Auto Amp Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R214	Auto Amp Plate Decoupling	RESISTOR: 100,000 ohm p/m 10%, 1/2 w	745 1170 00
R215	Frequency Compensation	RESISTOR: .22 megohm p/m 5%, 1/2 w	745 1183 00
R216	Auto Phase Detector Cathode	RESISTOR: 2200 ohm p/m 10%, 1/2 w	745 1100 00
R217	Auto Phase Detector Grid Network	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R218	Auto Phase Detector Cathode	RESISTOR: 1500 ohm p/m 10%, 1/2 w	745 1093 00
R219	Auto Phase Detector Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R220	Auto Reactor Control Bias	RESISTOR: 20,000 ohm p/m 5%, 1/2 w	745 1140 00
R221	Auto Reactor Control Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R222	Auto Reactor Control Grid	RESISTOR: 470,000 ohm p/m 10%, 1/2 w	745 1198 00
R223	Auto Sensitivity	RESISTOR: 10,000 ohm p/m 20%, 2 w (Variable)	380 0320 00
R224	Auto Phase Det Plate	RESISTOR: 220,000 ohm p/m 10%, 1/2 w	745 1184 00
R225	Auto Centering	RESISTOR: 1000 ohm p/m 20%, 2 w (Variable)	380 0319 00
R226	Auto Regulator Grid	RESISTOR: 1.5 megohm p/m 10%, 1/2 w	745 1219 00
R227	Auto Regulator Cathode	RESISTOR: 1,000 ohm p/m 10%, 1/2 w	745 1086 00
R228	Auto Regulator Plate	RESISTOR: 12,000 ohm p/m 10%, 2 w	745 9143 00
R229	Voltage Divider	RESISTOR: 22 ohm p/m 10% 2 w	745 9027 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
R230	Voltage Divider	RESISTOR: 160 ohm p/m 5%, 10 w	710 0196 00
R231	To-From Load	RESISTOR: 2200 ohm p/m 10%, 1/2 w	745 1100 00
R232	To-From Load	RESISTOR: 2200 ohm p/m 10%, 1/2 w	745 1100 00
R233	To-From Phase Splitting	RESISTOR: 5600 ohm p/m 10%, 1/2 w	745 1118 00
R234	Current Stabilizer	RESISTOR: 470 ohm p/m 1%, 1/4 w	748 0017 00
R235	Current Stabilizer	RESISTOR: 470 ohm p/m 1%, 1/4 w	748 0017 00
R236	Loc Centering	RESISTOR: 10,000 ohm p/m 10%, 2 w (Variable)	750 8061 00
R237	Flag Adjust	RESISTOR: 35 ohm p/m 10%, 2 w (Variable)	750 8067 00
R238	Localizer Flag	RESISTOR: 240 ohm p/m 3%, 2 w	747 9306 00
R239	CR-102 Bridge Load	RESISTOR: 470 ohm p/m 1%, 1/4 w	748 0017 00
R240	Phase Centering	RESISTOR: 100 ohm p/m 10% 2 w (Variable)	750 8062 00
R241	CR-102 Bridge Load	RESISTOR: 470 ohm p/m 1%, 1/4 w	748 0017 00
R242		Not used	
R243	VOR Sensitivity	RESISTOR: 1000 ohm p/m 20%, 2 w (Variable)	380 0319 00
R244	Filament Balance	RESISTOR: 27.2 ohm p/m 5%, 4 w	747 9027 00
R245	Filament Dropping	RESISTOR: .63 ohm p/m 10%, 4 w	710 2405 00
R246	Filament Balance	RESISTOR: 72 ohm p/m 5%, 4 w	747 9031 00
R247	Filament Dropping	RESISTOR: .63 ohm p/m 10%, 4 w	710 2405 00
R248	Bleeder	RESISTOR: 470,000 52 ohm p/m 10%, 1/2 w	745 1198 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
S101	Coarse Freq. Positioner	SWITCH SECTION: For 20 position rotary switch	269 1079 00
S102	Coarse Freq. Positioner	SWITCH SECTION: For 20 position rotary switch	269 1387 00
S103	Coarse Freq. Positioner	SWITCH SECTION: For 20 position rotary switch	269 1388 00
S104	Fine Freq. Positioner	SWITCH SECTION: For 20 position rotary switch	269 1392 00
S105	Fine Freq. Positioner	SWITCH SECTION: For 20 position rotary switch	269 1082 00
S106	CF Crystal Selector	SWITCH SECTION: For 20 position rotary switch	269 1343 00
S107	FF Crystal Selector	SWITCH SECTION: For 20 position rotary switch	269 1085 00
T101	RF Input	TRANSFORMER: Variable RF, 2 RF coils mtd on plate	504 9354 002
T102	RF Amp - 1st Mixer	TRANSFORMER: Variable RF, 2 RF coils mtd on plate	504 9352 002
T103	Variable IF	TRANSFORMER: IF, 19.45 to 21.35 mc	504 9230 003
T104	Variable IF	TRANSFORMER: IF, 19.45 to 21.35 mc	504 9231 003
T105	Fixed IF	TRANSFORMER: Variable RF, 16.0 uh p/m 3%	504 9247 003
T106	Fixed IF	TRANSFORMER: Variable RF, 16.0 uh p/m 3%	504 9248 003
T107	Fixed IF	TRANSFORMER: Variable RF, 16.0 uh p/m 3%	504 9246 003
T108	Fixed IF	TRANSFORMER: Variable RF, 16.0 uh p/m 3%	504 9245 003
T109	Audio Output	TRANSFORMER: Audio, pri 20,000 ohm, secd 500 ohm	677 0198 00
T110	LF Inj. Osc. Plate	TRANSFORMER: IF, 16.3 to 18.2 mc	504 9229 003
T111	HF Inj. Amp Plate	TRANSFORMER: Variable RF, 2 RF chokes mtd on plate	504 9353 002
T112	Translater Amp Output	TRANSFORMER: AF, pri 600 ohm, secd 1950 ohm and 150 ohm, 6 ma DC	677 0368 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
T113	Ref. Phase Amp Input	TRANSFORMER: AF, pri 7,000 ohm, secd 1,847,000 ohm	673 0281 00
ALT T113		TRANSFORMER: Electrically identical to above	677 0476 00
T114	Ref Channel Output	TRANSFORMER: Af, pri 25,000 ohm, secd 1000 ohm, 1000 ohm, and 20,000 ohm, 6 ma bal	677 0517 00
T115	Var Channel Output	TRANSFORMER: AF, pri 25,000 ohm, secd 1000 ohm, 1000 ohm, and 20,000 ohm, 6 ma bal	677 0517 00
T116	Auto Phase Det Input	TRANSFORMER: AF, pri 7,000 ohm, secd, 1,847,000 ohm	673 0281 00
ALT T116		TRANSFORMER: AF, electrically identical to above	677 0476 00
T117	Auto Saturable Reactor	REACTOR: 44 mh plus 40% minus 15%, 1.0 ma	678 0366 00
TB101	LF Osc Voltage	BOARD: Terminal, 2 solder lug term	504 9342 002
TB102	Front Panel	BOARD: Terminal, 5 solder lug term	505 5420 002
TB103	Rear Plug Spare Pin	BOARD: Terminal, 8 solder lug term	504 9427 002
V101	R-F Amplifier	TUBE: Type 5654 pentode	253 0001 00
V102	1st Mixer	TUBE: Type 5654 pentode	253 0001 00
V103	Var I-F Amp	TUBE: Type 5654 pentode	253 0001 00
V104	2nd Mixer	TUBE: Type 5654 pentode	253 0001 00
V105	1st Fixed I-F Amp	TUBE: Type 5654 pentode	253 0001 00
V106	2nd Fixed I-F Amp	TUBE: Type 5654 pentode	253 0001 00
V107	3rd Fixed I-F Amp	TUBE: Type 5654 pentode	253 0001 00
V108	Detector	TUBE: Type 5726 double diode	253 0003 00
V109	Squelch - Audio	TUBE: Type 5751 double triode	253 0012 00
V110	Audio-Noise Limiter	TUBE: Type 5814 double triode	253 0013 00
V111	H-F Inj Amp.	TUBE: Type 5654 pentode	253 0001 00
V112	H-F Oscillator	TUBE: Type 5670 double triode	253 0002 00
V113	L-F Oscillator	TUBE: Type 5654 pentode	253 0001 00
V114	Voltage Regulator	TUBE: Type OA2 voltage regulator	257 0052 00
V115	Ref Amp-Man Resolver Cathode Follower	TUBE: Type 5814 double triode	253 0013 00
V116	1st Limiter	TUBE: Type 5751 double triode	253 0012 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
V117	2nd Limiter	TUBE: Type 5751 double triode	253 0012 00
V118	Trans Amp-Auto Resolver Cathode Follower	TUBE: Type 5814 double triode	253 0013 00
V119	Ref. Phase Amp.	TUBE: Type 5814 double triode	253 0013 00
V120	Ref. Phase output Amp	TUBE: Type 5814 double triode	253 0013 00
V121	Var Phase Amp.	TUBE: Type 5814 double triode	253 0013 00
V122	Var Phase Output Amp	TUBE: Type 5814 double triode	253 0013 00
V123	Auto Voltage Amp	TUBE: Type 5814 double triode	253 0013 00
V124	Auto Phase Det.	TUBE: Type 5814 double triode	253 0013 00
V125	Auto Reactor Control	TUBE: Type 5814 double triode	253 0013 00
V126	Auto Inj & Regulator	TUBE: Type 5814 double triode	253 0013 00
XV101		SOCKET: Tube, 7 pin miniature	220 1111 00
XV102		SOCKET: Tube, 7 pin miniature	220 1111 00
XV103		SOCKET: Tube, 7 pin miniature	220 1111 00
XV104		SOCKET: Tube, 7 pin miniature	220 1111 00
XV105		SOCKET: Tube, 7 pin miniature	220 1111 00
XV106		SOCKET: Tube, 7 pin miniature	220 1111 00
XV107		SOCKET: Tube, 7 pin miniature	220 1111 00
XV108		SOCKET: Tube, 7 pin miniature	220 1111 00
XV109		SOCKET: Tube, 9 pin miniature	220 1103 00
XV110		SOCKET: Tube, 9 pin miniature	220 1103 00
XV111		SOCKET: Tube, 9 pin miniature	220 1103 00
XV112		SOCKET: Tube, 7 pin miniature	220 1111 00
XV113		SOCKET: Tube, 7 pin miniature	220 1111 00
XV114		SOCKET: Tube, 7 pin miniature	220 1111 00
XV115		SOCKET: Tube, 9 pin miniature	220 1103 00
XV116		SOCKET: Tube, 9 pin miniature	220 1103 00
XV117		SOCKET: Tube, 9 pin miniature	220 1103 00
XV118		SOCKET: Tube, 9 pin miniature	220 1103 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
XV119		SOCKET: Tube, 9 pin minature	220 1103 00
XV120		SOCKET: Tube, 9 pin miniature	220 1103 00
XV121		SOCKET: Tube, 9 pin miniature	220 1103 00
XV122		SOCKET: Tube, 9 pin miniature	220 1103 00
XV123		SOCKET: Tube, 9 pin miniature	220 1103 00
XV124		SOCKET: Tube, 9 pin miniature	220 1103 00
XV125		SOCKET: Tube, 9 pin miniature	220 1103 00
XV126		SOCKET: Tube, 9 pin miniature	220 1103 00
XY101 thru XY114		SOCKET: Crystal for 14 xtals in type HC-6 xtal holders	292 0072 00
XY115 thru XY134		SOCKET: Crystal for 20 xtals in type HC-6 xtal holders	292 0070 00
Y101		CRYSTAL: Quartz, 44.27500 mc	291 9969 00
Y102		CRYSTAL: Quartz, 45.27500 mc	291 9970 00
Y103		CRYSTAL: Quartz, 46.27500 mc	291 9971 00
Y104		CRYSTAL: Quartz, 47.27500 mc	291 9972 00
Y105		CRYSTAL: Quartz, 48.27500 mc	291 9973 00
Y106		CRYSTAL: Quartz, 49.27500 mc	291 9974 00
Y107		CRYSTAL: Quartz, 50.27500 mc	291 9975 00
Y108		CRYSTAL: Quartz, 51.27500 mc	291 9976 00
Y109		CRYSTAL: Quartz, 52.27500 mc	291 9977 00
Y110		CRYSTAL: Quartz, 53.27500 mc	291 9978 00
Y111		CRYSTAL: Quartz, 54.27500 mc	291 9979 00
Y112		CRYSTAL: Quartz, 55.27500 mc	291 9980 00
Y113		CRYSTAL: Quartz, 56.27500 mc	291 9981 00
Y114		CRYSTAL: Quartz, 57.27500 mc	291 9982 00
Y115		CRYSTAL: Quartz, 8150.000 kc	291 9949 00
Y116		CRYSTAL: Quartz, 8200.000 kc	291 9950 00
Y117		CRYSTAL: Quartz, 8250.000 kc	291 9951 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
Y118		CRYSTAL: Quartz, 8300.000 kc	291 9952 00
Y119		CRYSTAL: Quartz, 8350.000 kc	291 9953 00
Y120		CRYSTAL: Quartz, 8400.000 kc	291 9954 00
Y121		CRYSTAL: Quartz, 8450.000 kc	291 9955 00
Y122		CRYSTAL: Quartz, 8500.000 kc	291 9956 00
Y123		CRYSTAL: Quartz, 8550.000 kc	291 9957 00
Y124		CRYSTAL: Quartz, 8600.000 kc	291 9958 00
Y125		CRYSTAL: Quartz, 8650.000 kc	291 9959 00
Y126		CRYSTAL: Quartz, 5800.000 kc	291 9960 00
Y127		CRYSTAL: Quartz, 8750.000 kc	291 9961 00
Y128		CRYSTAL: Quartz, 8800.000 kc	291 9962 00
Y129		CRYSTAL: Quartz, 8850.000 kc	291 9963 00
Y130		CRYSTAL: Quartz, 5933.333 kc	291 9964 00
Y131		CRYSTAL: Quartz, 8950.000 kc	291 9965 00
Y132		CRYSTAL: Quartz, 9000.000 kc	291 9966 00
Y133		CRYSTAL: Quartz, 9050.000 kc	291 9967 00
Y134		CRYSTAL: Quartz, 9100.000 kc	291 9968 00
Z101	Audio Filter	FILTER: High pass, 3000 cps, 10 v RMS output v	673 0166 00
Z102	9960 Band Pass Filter	FILTER: Bandpass, 10,160 cps at .6 v RMS 20°C	673 0190 00
Z103	Variable Channel Filter	REACTOR: Filter, 858 hy at .2 v RMS	678 0364 00
Z104	Phase Positioning and LP Filter	PHASING UNIT: 8 capacitors and 4 resistors sealed	799 0001 00
Z105	90∼ Localizer Filter	FILTER: Band pass, 90 cps resonant frequency	673 0274 00
Z106	150∼ Localizer Filter	FILTER: Band pass, 150 cps	673 0275 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION		PART NUMBER
416N-1 POWER SUPPLY				506 1453 004
C301	High voltage filter	CAPACITOR, Paper: 3.9 mf ± 3% at 60 cps, 330 WV ac at 60 cps		930 0096 00
C302	High voltage filter	CAPACITOR, Paper: 3.9 mf ± 3% at 60 cps, 330 WV ac at 60 cps		930 0096 00
C303	High voltage noise filter	CAPACITOR, Paper: 0.1 mf ± 20%, 600 WV		930 0029 00
C304	Low voltage noise filter	CAPACITOR, Paper: 1.3 mf ± 20%, 50 WV		930 0004 00
C305	Primary noise filter	CAPACITOR, Mica: 10,000 mmf ± 20%, 300 WV		JAN type # CM35A103M
C306	Secondary noise filter	CAPACITOR, Mica: 6200 mmf ± 5%, 500 WV		JAN type # CM35A622J
C307	High voltage filter	CAPACITOR, Paper: 3.9 mf ± 6% at 60 cps, 330 WV ac at 60 cps		930 0095 00
C308	High voltage filter	CAPACITOR, Paper: 3.9 mf ± 6% at 60 cps, 330 WV ac at 60 cps		930 0095 00
D301	Receiver power	DYNAMOTOR: Input: 26.5 v dc at 2.6 amp; output: 260 v dc at .135 amp; (includes C305 and C306 listed above)		231 0177 00
	Replaceable parts for D301	FIELD COIL (Set),	(1)	234 0172 00
		BRUSH HOLDERS (Input)	(2)	234 0173 00
		BRUSH ASSEMBLY (Input)	(2)	234 0174 00
		BRUSH HOLDER CAP	(4)	234 0175 00
		BRUSH HOLDER (Output)	(2)	234 0176 00
		BRUSH ASSEMBLY (Output)	(2)	234 0177 00
		ARMATURE ASSEMBLY, includes one armature, 2 grease slingers and 2 bearings	(1)	234 0178 00
		BEARING	(2)	234 0167 00
L301	High voltage filter	REACTOR, Filter: 3.62 hy ± 5% at 1.3 v, 30 cps, 1600 rms TV		678 0210 00
L302	High voltage filter	REACTOR, Filter: 7.5 hy, 10 v, 60 cps; 1600 rms TV		678 0211 00
L303	High voltage noise filter	COIL, RF Choke: 1 mh ± 10%, 300 ma		240 5800 00
L304	Primary power noise filter	COIL, RF Choke: .058 mh powdered iron core		240 0048 00
P301	Power plug	CONNECTOR, Male Contact: 6 term, wall mtg		365 2060 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
P302	Mounting base power plug	CONNECTOR, Male Contact: 3 term, wall mtg	357 3012 00
X301	Mounting base power socket	CONNECTOR, Female Contact: 6 term	366 2060 00
			504 4232 004
314U-5 CONTROL UNIT			
I401		LAMP, instrument: 3 v, 0.19 amp; special screw base	262 0064 00
S401 A		SWITCH, rotary: 14 position; bakelite	269 1073 00
S401 B		SWITCH, rotary: 14 position; bakelite	269 1074 00
S401 C		SWITCH, rotary: 14 position; bakelite	269 1075 00
S401 D		SWITCH, rotary: 50 position; bakelite	269 1076 00
S401 E		SWITCH, rotary: 20 position; bakelite	269 1263 00
S401 F		SWITCH, rotary: 20 position; bakelite	269 1262 00
S402		SWITCH, TOGGLE: SPST; 3 amp, 250 v	260 0833 00
351A-1 ACCESSORY UNIT			505 5440 004
	Filter (qty 4)	CAPACITOR, Paper: 3.9 mf ± 6% at 60 cps; 330 WV ac, 60 cps	930 0095 00
J501		CONNECTOR: Female contact: 45 term	370 2034 00
P501	Omni-bearing connector (#1)	CONNECTOR; female contact: 17 term; wall mtg; shell size 20	357 9023 00
P502	Omni-bearing connector (#2)	CONNECTOR, female contact: 17 term; wall mtg; shell size 20	357 9023 00
P503	Servo amplifier connector (pilot)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P504	Servo amplifier connector (co-pilot)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P505	Servo amplifier connector (navigator)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
P506	Power supply connector (#1)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P507	Power supply connector (#2)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P508	Rear connector	CONNECTOR, male contact: 45 term; wall mtg	370 2033 00
	Accessory unit shock mount assembly	MOUNT, vibration: Basic assembly	503 5801 004
	Rubber mounting feet	MOUNT SET, vibration: 40 lb. load (qty 4)	200 0158 00
333B-1			520 3724 00
333B-3	SERVO AMPLIFIER	(Base for 333B-1)	520 3723 00
C601	Cathode bypass	CAPACITOR, Paper: .2 mf ± 20%, 120 WV	931 0151 00
C602	Cathode bypass	CAPACITOR, Paper: .2 mf ± 20%, 120 WV	931 0151 00
C603	Output filter	CAPACITOR, Paper: Dual sect; .1/.1 mf +40 -15%, 600 WV	961 5038 00
C604	Output filter	CAPACITOR, Paper: Dual sect; .1/.1 mf +40 -15%, 600 WV	961 5038 00
C605	Output filter	CAPACITOR, Paper: 2 mf -20 +30%, 100 WV	931 0039 00
*E601	333B-3 Connector strip	STRIP: 6 term, bakelite	367 0121 00
*J601	333B-3 connector plug receptacle	CONNECTOR: 6 prong chassis mtg	366 2060 00
P601	Power plug	CONNECTOR, Male Contact: 6 term chassis mtg	365 2060 00
R601	Input resistance	RESISTOR: 470 ohm ± 20%, 1/2 w	745 1073 00
R602	V601 grid 7 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R603	V601 grid 3 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R604	V601 cathode 2	RESISTOR: 2700 ohm ±10%, 1/4 w	745 0104 00
R605	V601 cathode 8	RESISTOR: 2700 ohm ±10%, 1/4w	745 0104 00
R606	V601 Common cathode	RESISTOR: 1500 ohm ±10%, 1/4w	745 0093 00

*Use with 333B-3 only

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
T601	Amplifier input	TRANSFORMER, Input: Turns ratio 1:20; Pri reactance greater than 1000 ohms at 0.25 v rms 400 cps; Pri input 0-5 v, 400 cps	677 0220 00
T602	Amplifier output	REACTOR, Saturable: DC winding: 4750 ohms ± 20%; 8 ma max: AC winding: 7.5 ohm ± 10%; 110 ma max; 500 TV rms	678 0204 00
T603	Auto-transformer	TRANSFORMER, auto: 400 cps; 150 v 10 ma/115 v, 100 ma/26.5 v; 230 ma/6.3 v, 350 ma; 2500 TV	672 0221 00
V601	Amplifier	TUBE, Electron: Type 2C51, dual triode	253 0002 00
XV601	Socket for V601	SOCKET, Tube: miniature, 9 term, phenolic	220 1051 00
336A-2 OMNI-BEARING SELECTOR			504 2568 005
B701	Resolver	AUTOSYN RESOLVER:	230 0077 00
I701	Dial lamp	LAMP, Instrument: 3 v, 0.19 amp; special screw base	262 0064 00
M701	Indicator	METER: 250-0-250 microamperes DC; perm magnet movable coil	458 0112 00
P701	Connector	CONNECTOR, Male contact: 10 term; wall mtg; shell size 18	357 3006 00
S701	Switch	SWITCH: Consists of: SEGMENT: 2 stator contacts (qty 2) CONTACT: Right CONTACT: Left	 503 7161 001 503 5342 001 503 5343 001
XI701		MOUNTING: Pilot light	503 5291 001
416N-2 POWER SUPPLY			520 4090 00
C801	H-V filter	CAPACITOR: Paper, 3.9 mf ± 3%, 330 WV	930 0096 00
C802	H-V filter	CAPACITOR: Paper, 3.9 mf ± 3%, 330 WV	930 0096 00
C803	H-V filter	CAPACITOR: Paper, 0.1 mf ± 20%, 600 WV	930 0029 00
C804	Dynamotor input filter	CAPACITOR: Paper 1.3 mf ± 20%, 50 WV	930 0004 00
C805	Dynamotor input filter	CAPACITOR: Paper, 1.3 mf ± 20%, 50 WV	930 0004 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
C806	H-V filter	CAPACITOR: Paper, 3.9 mf ± 6%, 330 WV	930 0095 00
C807	H-V filter	CAPACITOR: Paper, 3.9 mf ± 6%, 330 WV	930 0095 00
C808	Dynamotor input filter	CAPACITOR: Mica, 10,000 mmf ± 20%, 300 WV	JAN type # CM35A103M
C809	Dynamotor input filter	CAPACITOR: Mica, 10,000 mmf ± 20%, 300 WV	JAN type # CM35A103M
C810	Dynamotor output filter	CAPACITOR: Mica, 6200 mmf ± 5%, 500 WV	JAN type # CM35A622J
D801	H-V power	DYNAMOTOR: Dual input voltage, 13.25 v DC or 26.5 v DC nom; output 260 v DC + 3% -5% at 135 ma +26.5 v with 13.25 v input (includes C808, C809, C810 listed above)	231 0037 00
	Replaceable parts for D801	FIELD COIL (Set) (1)	234 0157 00
		BRUSH HOLDER (Input) (2)	234 0158 00
		BRUSH ASSEMBLY (Input) (2)	234 0168 00
		BRUSH HOLDER CAP (Input) (2)	234 0160 00
		BRUSH HOLDER (Output) (4)	234 0161 00
		BRUSH ASSEMBLY (Output) (2)	234 0169 00
		BRUSH ASSEMBLY (Output) (2)	234 0163 00
		BRUSH HOLDER CAP (2)	234 0164 00
		BRUSH HOLDER CAP (2)	234 0165 00
		Armature Assembly, includes one armature, 2 grease slingers, and 2 bearings (1)	234 0166 00
		BEARING (2)	234 0167 00
E801	Dynamotor	STRIP: 4 terminal connectors	367 0002 00
L801	H-V filter	REACTOR: Filter, 3.62 hy ± 5% at 1.3 v 30 cps, 1600 rms TV	678 0210 00
L802	H-V filter	REACTOR: Filter, 7.5 hy, 10 v, 60 cps 1600 rms TV	678 0211 00
L803	H-V filter	COIL: RF choke, 1 mh ± 10%, 300 ma	240 5800 00
L804	Dynamotor input filter	COIL: RF choke, .058 mh, powdered iron core	240 0048 00
L805	Dynamotor input filter	COIL: RF choke, 0.058 mh powdered iron core	240 0021 00
P801	Power unit input and output connector	CONNECTOR: 4 contact, pin insert	357 3013 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
337A-2 OMNI-BEARING INDICATOR			504 3191 004
B901	Control motor	MOTOR: 2 phase 400 cps, 18 v rms and 1.5 w per phase	230 0107 00
B902	Phase shifter	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pri exciter with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
B903	Differential	AUTOSYN DIFFERENTIAL: Y connected 3 phase rotor and stator; normal excitation output voltage from 26 v 400 cps single phase excited autosyn	230 0076 00
P901	Control wire connector	CONNECTOR: 17 contact plug, pin insert, box mtg	357 3077 00
339A-1 RECTIFIER UNIT			596 0468 004
T301	Power Transformer		596 0471 005
V301	Rectifier	26Z5W	255 0208 00
V302	Rectifier	26Z5W	255 0208 00
416N-4 POWER SUPPLY			505 3705 003
C301	High voltage filter	CAPACITOR, Paper: 3.9 mf p/m 3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
C302	High voltage filter	CAPACITOR, Paper: 3.9 mf p/m 3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
K301	Relay	RELAY: Armature, 26.5 v, 480 ohms p/m 10%	972 1278 00
L301	High voltage filter	REACTOR, Filter: 3.62 hy p/m 5% at 1.3 v, 30 cps; 1600 v rms TV	678 0210 00
L302	High voltage filter	REACTOR, Filter: 7.5 hy, 10 v 60 cps; 1600 v rms TV	678 0211 00
P301	Power connector	CONNECTOR, Male contact: 6 terminal, wall mounting	365 2060 00
P302	Mounting base power plug	CONNECTOR, Male contact: 3 terminal, wall mounting	357 3012 00
R301	Bleeder	RESISTOR: 1 megohm p/m 10%, 1 w	745 3212 00
X301	Mounting base power socket	CONNECTOR, Female contact: 6 terminal	366 2060 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	PART NUMBER
416N-5 POWER SUPPLY			505 3706 003
C301	High voltage filter	CAPACITOR, Paper: 3.9 mf p/m 3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
C302	High voltage filter	CAPACITOR, Paper: 3.9 mf p/m 3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
K301	Relay	RELAY, Armature: 26.5 v, 480 ohm p/m 10%	972 1278 00
L301	High voltage filter	REACTOR, Filter: 3.62 hy p/m 5% at 1.3 v, 30 cps; 1600 v rms TV	678 0210 00
L302	High voltage filter	REACTOR, Filter: 7.5 hy, 10 v 60 cps; 1600 v rms TV	678 0211 00
P301	Power connector	CONNECTOR, Male contact: 6 terminal, wall mounting	365 0006 00
R301	Bleeder	RESISTOR: 1 megohm p/m 10% 1 w	745 3212 00
T301	Power transformer	TRANSFORMER, Power: primary 115 v, 380-1000 cycle; secondaries - 540 v center tapped, 135 ma - 6.3 v at 1.8 a	672 0437 00
V301	Rectifier	5993	257 0067 00
V302	Rectifier	5993	257 0067 00

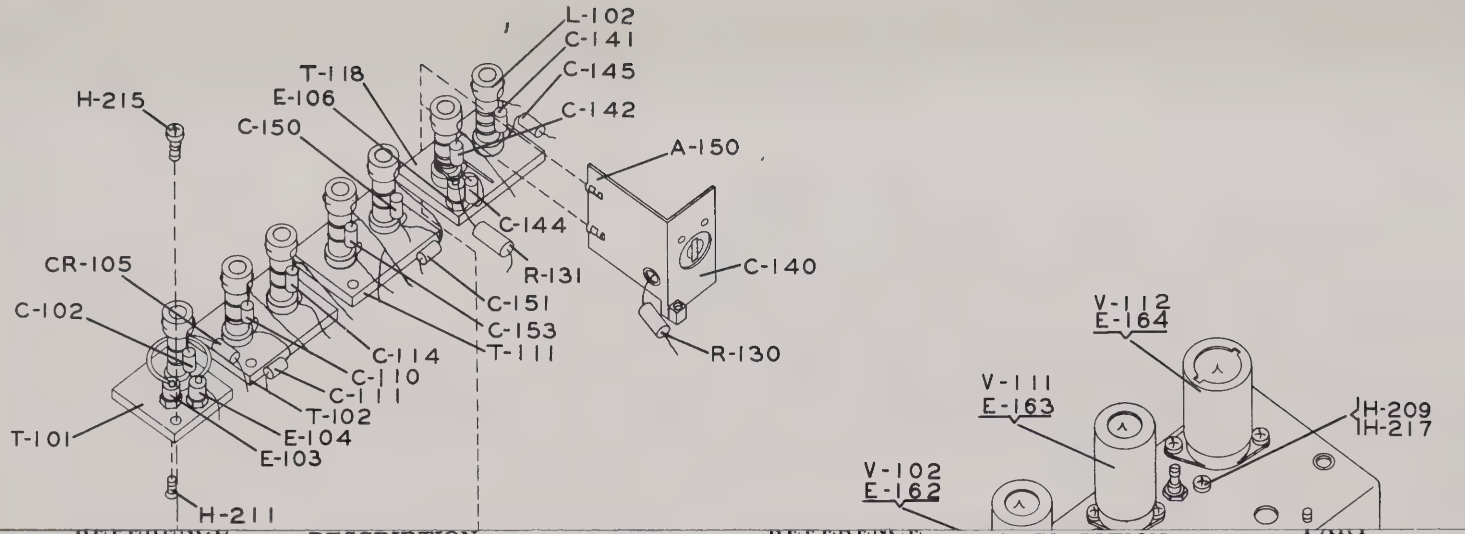
MODEL 888 BLIND APPROACH INDICATOR

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Case - Assembled	122449	1
Case	117949	1
Front	117951	1
Gasket	117952	1
Screw (#4-48) (Case to Front)	100120	6
Screw (#2-64) (Case to Front)	108328	2
Glass	117953	1
Mask-Printed	121640	1
Clip (Glass to Front)	117957	4
Screw (Clip to Front)	89595	4
Stud (Zero Corrector)	114027	2
Crank (Zero Corrector)	71356	2
Washer (Zero Corrector)	93101	2
Lamp & Switch Assembly	ND 23860	1
Screw - Hexagon Socket Set (#6-32 x 1/8")	ND 23864	2
Base	117958	1
Screw (Case to Base)	108327	4
Shield	122450	1
Gasket (Shield to Base)	117960	1
Receptacle - 10 pin (AN3102-18-1P)	ND 24109	1
Gasket - 10 Pin Receptacle	117962	1
Receptacle - 3 Pin (AN3102-14S-7P)	ND23858	1
Gasket - 3 Pin Receptacle	117963	1
Screw (Mounting Receptacles)	102387	8
Washer - Lock (Mounting Receptacles)	ND22637	8
Screw (Shield to Base)	89576	4
Washer - Lock (Shield to Base)	ND22231	4
Plate - Assembled, Movement	120994	1
Nut (Plate to Base)	120996	4
Screw - #6-32 x 3/8" (Plate to Base)	ND 19672	4
Washer - Lock (Plate to Base)	ND 22231	4
Base - Movement	117964	4
Screw - #6-32 x 5/16" (Base to Plate)	ND20931	4
Stud - Case Guide	120997	2
Tube - Insulating	120998	4
Washer - Lock Move. Base to Plate	ND 22231	8
Stud - Case Guide and Stop	124767	2
Magnet - Assembled	117965	4
Screw (Magnet to Move. Base)	120999	8
Washer - Lock (Magnet to Move. Base)	ND 22231	8
Bracket - Assembled, Movement	117967	4
Stud - Bracket to Magnet	117973	8
Washer - Lock (Bracket to Magnet)	ND21895	8
Terminal	23920	4
Element - Assem., Moving Localizer (Type 3Y-2)	117974	1
Element - Assem., Moving Localizer (Type 3Z-2)	123727	1
Pointer Assembled Type 3Y-2	117975	1
Pointer Assembled Type 3Z-2	123729	1
Frame - Wound	121529	1
Springs - Paired 34 Total Test	110824	1 pr.
Pivot	88239	2
Nut	22960	2

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Weight - Spiral Balance 4 Turns	107381	
Weight - Spiral Balance 6 Turns Side Arms	107382	
Weight - Spiral Balance 8 Turns As required	106356	2
Weight - Spiral Balance 12 Turns	81041	1
Nut - - Tail	108529	1
Nut - - As required	122590	1
Element - Assem., Moving, Glide Path (Type 3Y-2)	117978	1
Element - Assem., Moving, Glide Path (Type 3Z-2)	123726	1
Pointer Assembled Type 3Y-2	117979	1
Pointer Assembled Type 3Z-2	123728	1
Frame Wound	121529	1
Springs - Paired 34 Total Test	110824	1 pr.
Pivot	88239	2
Nut	22960	2
Weight - Spiral Balance 4 Turns	107381	
Weight - Spiral Balance 6 Turns Side Arms	107382	
Weight - Spiral Balance 8 Turns As required	106356	2
Weight - Spiral Balance 12 Turns	81041	
Nut - - Tail	122590	
Nut - - As required	86808	1
Element - Assembled, Moving Localizer Flag Alarm	117981	1
Pointer Assembled	117982	1
Frame - Wound	117985	1
Springs - Paired 30 Total Test	107071	1 pr.
Pivot	88239	2
Nut	22960	2
Weight - Spiral Balance 4 Turns	107381	
Weight - Spiral Balance 6 Turns Side Arms	107382	
Weight - Spiral Balance 8 Turns As required	106356	2
Weight - Spiral Balance 12 Turns	81041	
Nut - - Tail	108539	
Nut - - As required	86808	1
Element - Assembled, Moving, Glide Slope Flag Alarm	117987	1
Pointer Assembled	117988	1
Frame - Wound	117985	1
Spring - Paired 30 Total Test	107071	1 pr
Pivot	88239	2
Nut	22960	2
Weight - Spiral Balance 4 Turns	107381	
Weight - Spiral Balance 6 Turns Side Arms	107382	
Weight - Spiral Balance 8 Turns As required	106356	2
Weight - Spiral Balance 12 Turns	81041	
Nut - - Tail	108539	
Nut - - As required	86808	1
Screw - Jewel	106815	8
Spring - Cushion, Right Loc & Glide Path	117990	2
Spring - Cushion, Left Flag Alarm	121003	2
Spring - Cushion, Right Flag Alarm	121004	2
Spring - Cushion, Left Loc. & Glide Path	123074	2
Screw (Mounting Cushion Springs)	52427	8
Washer - Lock (Mounting Cushion Springs)	27088	8
Plate - Scale, Printed Type 3Y-2	117991	1

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Plate - Scale, Printed Type 3Z-2	123586	1
Screw (Mounting Scale Plate)	116863	2
Washer - Lock (Mounting Scale Plate)	30153	2
Spool #68 - - Wound 750 ohms	107645	4
Spool #68 - - Wound 5000 ohms	107652	2
Spool #68 - - Wound 1600 ohms	40419	2
Screw Mounting Spools	102401	8
Lamp - 28 Volt Mazda #313	ND23861	1
Screw (#6-32 x 1" long) (Mtg. Inst. to Panel)	89569	3
Nuts - Tinnerman (#6-32 Thds.) (Mtg. Inst. to Panel)	ND 23552	3

R-F Subassembly Identifying Parts

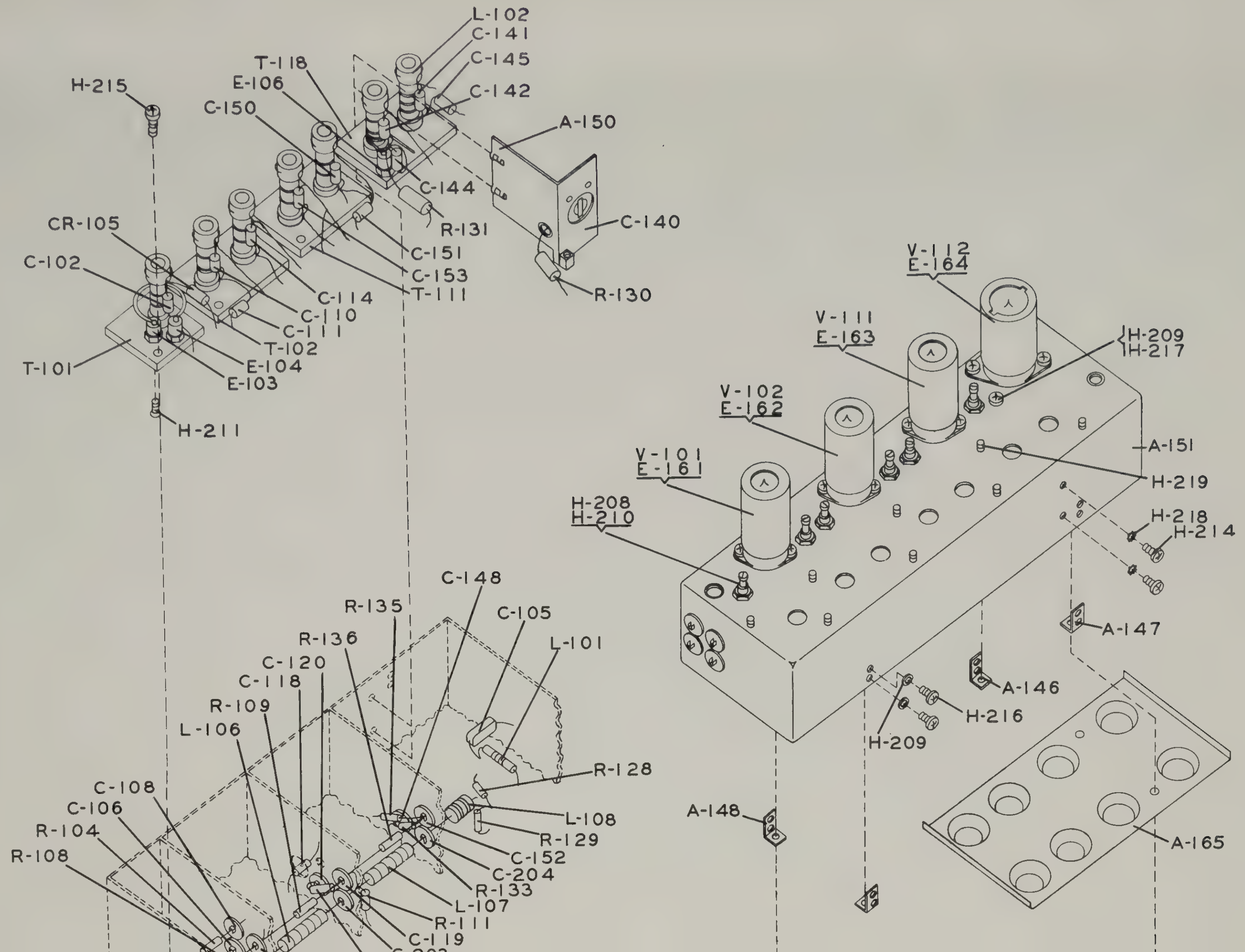


REFERENCE SYMBOL	DESCRIPTION	NUMBER
A-131	Cover - shield box	505 4585 003
*A-146	Bracket, mounting	504 9345 001
*A-147	Bracket, mounting	504 9345 001
*A-148	Bracket, mounting	504 9345 001
*A-149	Bracket, mounting	504 9345 001
*A-150	Plate, shield (includes C-140)	504 9787 002
A-151	Box, shield	506 1105 003
A-165	Shielding	505 4045 002
E-103	Post, insulated	306 0234 00
E-104	Post, insulated	306 0234 00
E-105	Post, insulated	306 0234 00
E-106	Post, insulated	306 0234 00
E-107	Post, insulated	306 0234 00
E-120	Post, insulated	306 0234 00
E-161	Shield, tube	141 0143 00
E-162	Shield, tube	141 0143 00
E-163	Shield, tube	141 0143 00
E-164	Shield, tube	141 0146 00
H-126	Nut, #4-40 Hex	313 0112 00
H-137	Screw #4-40 x 3/16 PBH	343 0416 00
H-142	Washer #4 ext. tooth lock	373 5010 00

REFERENCE SYMBOL	DESCRIPTION	PART NUMBER
H-175	Terminal, #4, solder	304 3110 00
H-207	Terminal, solder	304 0084 00
H-208	Washer, #12 split lock	310 0246 00
H-209	Washer, #4 split lock	310 3340 00
H-210	Nut, #12-28 special	334 0256 00
H-211	Screw, #4-40 x 5/16 PFH	342 0153 00
H-212	Screw, #4-40 x 3/16 PBH	343 0284 00
H-213	Screw, #4-40 x 3/16 PBH	343 0285 00
H-214	Screw, #4-40 x 5/16 PBH	343 0286 00
H-215	Screw, #4-40 x 1/2 PBH	343 0289 00
*H-216	Screw, #4-40 x 3/16 PBH	347 0089 00
H-217	Screw, #4-40 x 5/16 PFH	347 0091 00
H-218	Washer #4 ext. tooth lock	373 7010 00
H-219	Stud, #4-40 x 5/8	312 0066 00

*Early models were equipped as shown in diagram. Later models (serial numbers greater than 1000 approximately) were equipped with shield plate (A-150) 505 4292 002, which has one laceration instead of the two shown on the diagram and is mounted by mounting brackets, A-146 thru A-149 (504 6022 001), which are secured to the shield box with rivets 305 0167 00 instead of screws.

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Plate - Scale, Printed Type 3Z-2	123586	1
Screw (Mounting Scale Plate)	116863	2
Washer - Lock (Mounting Scale Plate)	30153	2
Spool #68 - - Wound 750 ohms	107645	4
Spool #68 - - Wound 5000 ohms	107652	2
Spool #68 - - Wound 1600 ohms	40419	2
Screw Mounting Spools	102401	8
Lamp - 28 Volt Mazda #313	ND23861	1
Screw (#6-32 x 1" long) (Mtg. Inst. to Panel)	89569	3
Nuts - Tinnerman (#6-32 Thds.) (Mtg. Inst. to Panel)	ND 23552	3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C-145
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C-151
C-153
C-102
C-114
T-111
R-130
C-110
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T-102
T-101
E-104
E-103
H-211
V-112
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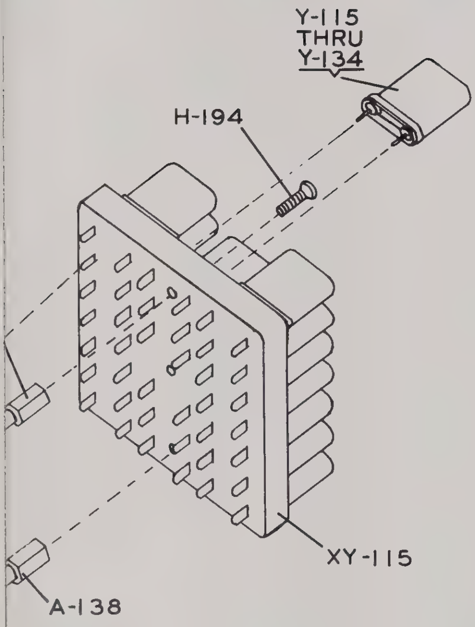
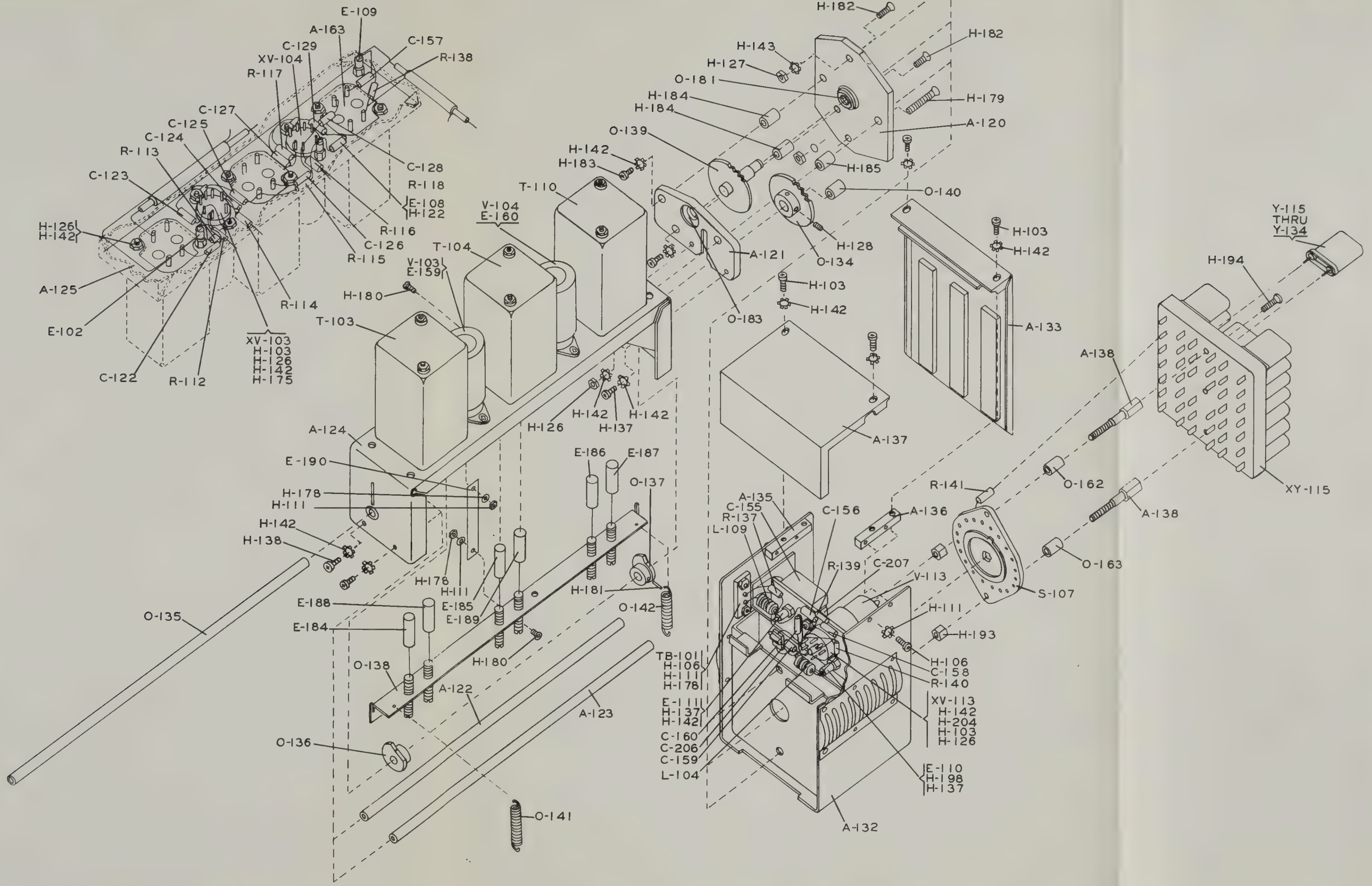


REFERENCE SYMBOL	DESCRIPTION	PART NUMBER
A-120	Plate, rear mounting	504 9208 002
A-121	Plate, front mounting	504 9207 002
A-122	Post, i-f tuner frame	504 9233 001
A-123	Post, i-f tuner frame	504 9233 001
A-124	Frame, tuning	504 9213 002
A-125	Plate, frame bottom	504 9227 002
A-132	Housing, fine frequency oscillator	504 9337 002
A-133	Cover, fine frequency crystal	504 9339 002
A-135	Bar, cover mounting	504 9336 001
A-136	Bar, cover mounting	504 9336 001
A-137	Cover, shield	505 4416 001
A-138	Support	504 9292 002
A-163	End Cap	505 7506 002
E-102	Post, insulated	306 0234 00
E-108	Post, insulated	306 0234 00
E-109	Post, insulated	306 0234 00
E-110	Post, insulated	306 0091 00
E-111	Post, insulated	306 0091 00
E-159	Shield, tube	141 0143 00
E-160	Shield, tube	141 0143 00
E-184	Slug assembly	503 5271 001
E-185	Slug assembly	503 5271 001
E-186	Slug assembly	503 5272 001
E-187	Slug assembly	503 5273 001
E-188	Slug assembly	503 5274 001
E-189	Slug assembly	503 5274 001
E-190	Strap, grounding	504 9209 002
H-103	Screw, #4-40 x 1/4 PBH	343 0418 00
H-106	Screw, #2-56 x 1/4 PBH	343 0456 00
H-111	Washer, #2	373 1010 00
H-127	Nut, #6-32 Hex	313 0117 00
H-128	Screw, #4-48 x 1/8 PBH	335 0019 00
H-138	Screw, #4-40 x 5/16 PBH	343 0420 00
H-143	Washer, #6 ext tooth lock	373 5020 00
H-178	Nut, #2-56 Hex	313 0013 00
H-179	Screw, #4-40 x 3/4 PFH	342 0288 00
H-180	Screw, #2-56 x 3/16 PBH	343 0454 00
H-181	Pin	311 7003 00
H-182	Screw, #4-40 x 1/4 PFH	342 0044 00
H-183	Screw, #4-40 x 5/16 PBH	343 0416 00
H-184	Post, spacing	504 9188 001
H-185	Post, spacing	504 9187 001
H-193	Stand off	500 2768 001
H-194	Screw, #4-40 x 1/2 PFH	342 0248 00
H-198	Washer, #4 split lock	310 0076 00
H-204	Terminal, #6 solder	304 4200 00
O-134	Gear	504 2838 001
O-135	Shaft, Cam	504 9189 001
O-136	Cam, i-f tuner	504 9198 002
O-137	Cam, i-f tuner	504 9199 002
O-138	Table, slug	504 9201 002
O-139	Gear, pinned	504 9204 002
O-140	Bushing	504 9192 001
O-141	Spring	504 9212 002
O-142	Spring	504 9212 002
O-162	Sleeve	504 9280 001
O-163	Sleeve	504 9280 001
O-181	Bearing	309 0116 00
O-183	Bearing	309 0133 00

Figure 11-2. Exploded View of Fine Frequency Tuner Identifying Parts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V-103
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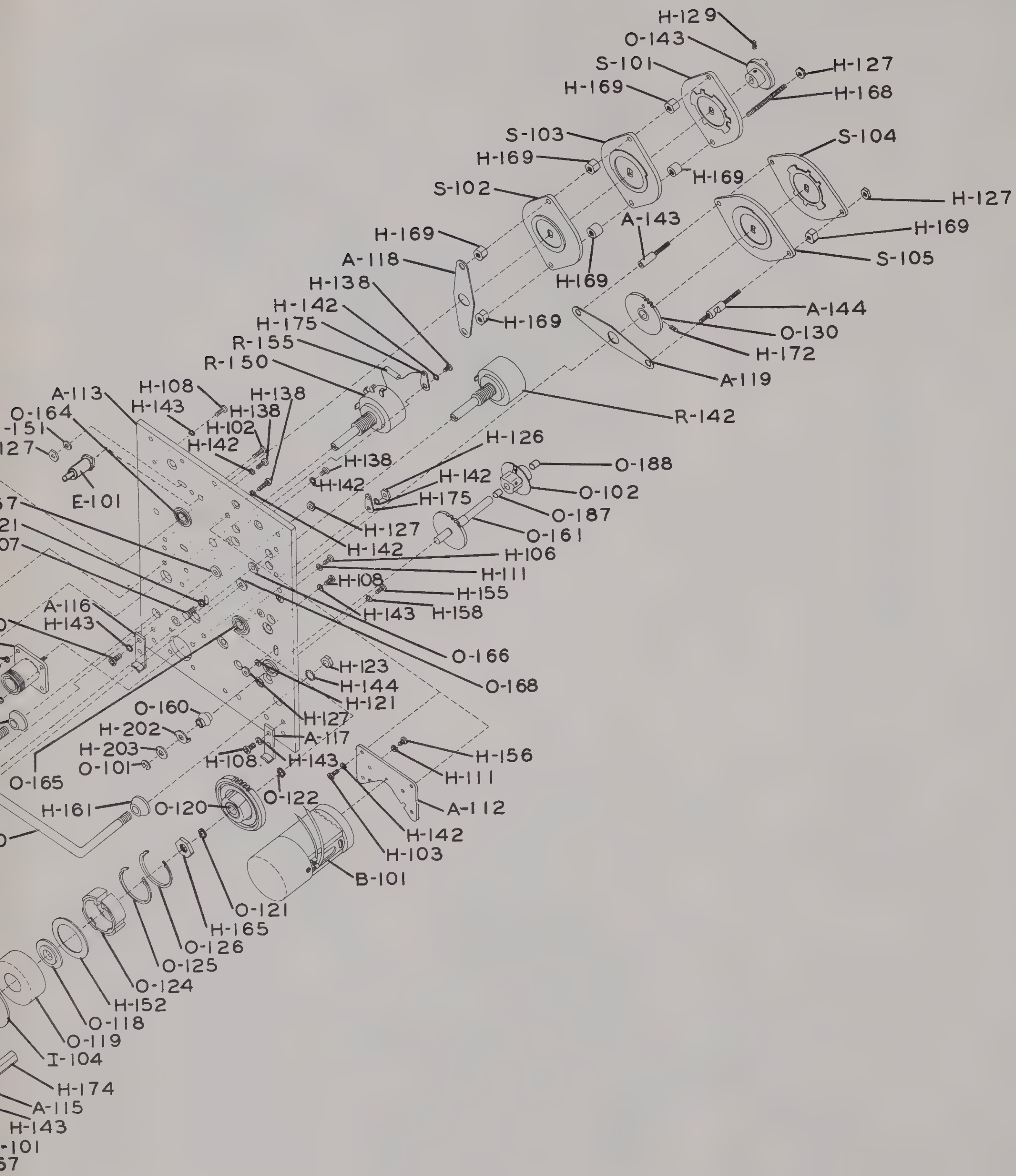
XY-115
R-139
C-207
V-113
H-111
H-193
H-106
C-158
R-140
S-107
O-163
TB-101
H-106
H-111
H-178
E-111
H-137
H-142
C-160
C-206
C-159
L-104
XV-113
H-142
H-204
H-103
H-126
E-110
H-198
H-137
A-132

REFERENCE SYMBOL	DESCRIPTION	PART NUMBER
A-120	Plate, rear mounting	504 9208 002
A-121	Plate, front mounting	504 9207 002
A-122	Post, i-f tuner frame	504 9233 001
A-123	Post, i-f tuner frame	504 9233 001
A-124	Frame, tuning	504 9213 002
A-125	Plate, frame bottom	504 9227 002
A-132	Housing, fine frequency oscillator	504 9337 002
A-133	Cover, fine frequency crystal	504 9339 002
A-135	Bar, cover mounting	504 9336 001
A-136	Bar, cover mounting	504 9336 001
A-137	Cover, shield	505 4416 001
A-138	Support	504 9292 002
A-163	End Cap	505 7506 002
E-102	Post, insulated	306 0234 00
E-108	Post, insulated	306 0234 00
E-109	Post, insulated	306 0234 00
E-110	Post, insulated	306 0091 00
E-111	Post, insulated	306 0091 00
E-159	Shield, tube	141 0143 00
E-160	Shield, tube	141 0143 00
E-184	Slug assembly	503 5271 001
E-185	Slug assembly	503 5271 001
E-186	Slug assembly	503 5272 001
E-187	Slug assembly	503 5273 001
E-188	Slug assembly	503 5274 001
E-189	Slug assembly	503 5274 001
E-190	Strap, grounding	504 9209 002
H-103	Screw, #4-40 x 1/4 PBH	343 0418 00
H-106	Screw, #2-56 x 1/4 PBH	343 0456 00
H-111	Washer, #2	373 1010 00
H-127	Nut, #6-32 Hex	313 0117 00
H-128	Screw, #4-48 x 1/8 PBH	335 0019 00
H-138	Screw, #4-40 x 5/16 PBH	343 0420 00
H-143	Washer, #6 ext tooth lock	373 5020 00
H-178	Nut, #2-56 Hex	313 0013 00
H-179	Screw, #4-40 x 3/4 PFH	342 0288 00
H-180	Screw, #2-56 x 3/16 PBH	343 0454 00
H-181	Pin	311 7003 00
H-182	Screw, #4-40 x 1/4 PFH	342 0044 00
H-183	Screw, #4-40 x 5/16 PBH	343 0416 00
H-184	Post, spacing	504 9188 001
H-185	Post, spacing	504 9187 001
H-193	Stand off	500 2768 001
H-194	Screw, #4-40 x 1/2 PFH	342 0248 00
H-198	Washer, #4 split lock	310 0076 00
H-204	Terminal, #6 solder	304 4200 00
O-134	Gear	504 2838 001
O-135	Shaft, Cam	504 9189 001
O-136	Cam, i-f tuner	504 9198 002
O-137	Cam, i-f tuner	504 9199 002
O-138	Table, slug	504 9201 002
O-139	Gear, pinned	504 9204 002
O-140	Bushing	504 9192 001
O-141	Spring	504 9212 002
O-142	Spring	504 9212 002
O-162	Sleeve	504 9280 001
O-163	Sleeve	504 9280 001
O-181	Bearing	309 0116 00
O-183	Bearing	309 0133 00

Figure 11-2. Exploded View of Fine Frequency Tuner Identifying Parts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B-101
O-121
H-165
O-126
O-125
O-124
H-152
O-118
O-119
I-104
H-174
A-115
H-143
-101
57

ference mbol	Description	Part Number
-126	Housing, Coarse Frequency crystal	504 9291 002
-127	Cover, Coarse Frequency crystal	504 9289 002
-128	Post, supporting	504 9293 002
-129	Post, supporting	504 9293 002
-141	Frame, Coarse Frequency Tuner	505 1480 002
-142	Post, supporting	504 9252 001
-191	Plate, insulating	505 1833 001
-193	Slug assembly	505 2654 002
-194	Slug assembly	505 2654 002
-195	Slug assembly	505 2654 002
-196	Slug assembly	505 2654 002
-197	Slug assembly	505 2654 002
-198	Slug assembly	505 2654 002
-199	Slug assembly	505 2654 002
-124	Nut, #4-40 Hex	313 0039 00
-125	Nut, #6-32 Hex	313 0045 00
-178	Nut, #2-56 Hex	313 0013 00
-186	Washer, felt	302 0068 00
-187	Washer, #2 int. tooth lock	373 1010 00
-188	Pin, taper	311 7010 00
-189	Screw, #5-40 x 3/16 PBH	343 0007 00
-190	Washer, #5 ext. tooth lock	373 0040 00
-191	Washer	504 9254 001
-192	Pin, guide	504 9263 002
-193	Post, spacing	500 5958 001
-194	Screw, #4-40 x 1/2 PFH	342 0284 00
-195	Screw, #4-40 x 1/2 PBH	343 0426 00
-196	Post, supporting	504 9276 001
-197	Post, spacing	504 9277 001
-198	Pin, taper	311 7003 00
-133	Bushing	504 9192 001
-144	Ring, retainer	340 0086 00
-145	Ring, retainer	340 0086 00
-146	Roller, cam	504 9262 002
-147	Roller, cam	504 9262 002
-148	Spring	504 9211 002
-149	Spring	504 9211 002
-150	Table, slug	504 9256 002
-151	Shaft, cam	504 9255 001
-152	Hub, coupler	504 9259 002
-153	Cam	504 9260 002
-154	Cam	504 9261 002
-156	Sleeve, insulating	504 9280 001
-157	Sleeve, insulating	504 9280 001
-158	Sleeve, insulating	505 1839 001
-159	Sleeve, insulating	505 1839 001
-186	Adapter, shaft	504 9425 002
-189	Spring, lock	504 9210 002

of Coarse Frequency Tuner Identifying Parts

51R-3 NAVIGATION RECEIVER

REFERENCE SYMBOL	DESCRIPTION	PART NUMBER
A-112	Plate, motor	504 8671 002
A-113	Panel, staked	505 4583 003
A-114	Plate, bearing	504 8664 002
A-115	Plate, bearing	504 8664 002
A-116	Bracket	504 8654 002
A-117	Bracket	504 8654 002
A-118	Bracket, switch adjust	504 8676 002
A-119	Bracket, switch adjust	504 8676 002
A-143	Post, switch A	504 9430 002
A-144	Post, switch B	504 9414 001
A-145	Plate, bearing	504 8652 002
E-101	Standoff, insulated	306 0234 00
H-101	Washer, #6 split lock	310 3260 00
H-102	Screw, #4-40 x 1/4 PFH	342 0276 00
H-105	Screw, #4-40 x 3/8 PBH	343 0422 00
H-106	Screw, #2-56 x 1/4 PBH	343 0456 00
H-107	Screw, #6-32 x 5/16 PBH	343 0033 00
H-108	Screw, #6-32 x 3/8 PBH	342 0384 00
H-110	Screw, #6-32 x 1/2 PBH	343 0497 00
H-111	Washer, #2 int. lock	373 1010 00
H-121	Washer, #6 flat	310 6360 00
H-123	Nut, 1/4 x 20 hex	313 0027 00
H-126	Nut, #4-40 hex	313 0112 00
H-127	Nut, #6-32 hex	313 0117 00
H-129	Screw, #6-40 x 1/8 set	335 0022 00
H-138	Screw, #4-40 x 5/16 PBH	343 0420 00
H-143	Washer #6 ext. tooth lock	373 5020 00
H-144	Washer, 1/4 ext. lock	373 8050 00
H-151	Washer, #6 flat	310 6360 00
H-152	Washer	504 8666 002
H-153	Nut, 3/8 - 32 Hex	334 4060 00
H-154	Screw, #2-56 x 1/4 PFH	342 0347 00
H-155	Screw, #6-32 x 3/8 PFH	342 0384 00
H-156	Screw, #2-64 x 1/4 PBH	343 0736 00
H-157	Screw, #6-32 x 3/8 PFH	347 0328 00
H-158	Washer #6 ext. tooth lock	373 0010 00
H-160	Handle	503 5086 002
H-161	Stop, handle	503 4943 001
H-162	Post, spacing	504 8641 001
H-163	Post, spacing	504 8642 001
H-164	Post, spacing	505 5418 001
H-165	Nut, 5/16 - 24	334 0249 00
H-166	Screw, #6-32 x 3/16 PBH	343 0166 00
H-167	Washer #6 ext. tooth lock	373 8020 00
H-168	Stud, #6-32 x 1 1/4	312 0082 00
H-169	Post hex	502 9382 001
H-171	Washer	504 8644 001
H-172	Screw, #4-48 x 3/16 set	335 0038 00
H-174	Post, spacing	504 8647 001
H-202	Washer, lock	504 9411 001
H-203	Washer, flat	504 9413 001
H-220	Screw	327 0006 00
I-103	Flange, Mc index	503 4924 001
I-104	Flange, .1 Mc index	503 4923 001
O-101	Ring, retainer	340 0113 00
O-102	Coupling, flexible	015 0011 00
O-103	Gear, staked "A"	504 8661 002
O-104	Gear, staked "B"	504 8662 002
O-105	Gear, staked idler	504 8663 002
O-106	Flange, clutch	503 4920 001
O-107	Drum, clutch	504 8667 002
O-108	Bearing, gear clutch	504 8668 002
O-109	Ring, retaining	340 0025 00
O-110	Shaft, autopositioner	505 5785 002
O-111	Clutch	502 1825 002
O-112	Spring, clutch	502 7029 002
O-113	Spring, clutch	502 7029 002
O-115	Pawl	503 5079 002
O-116	Ring, retaining	340 0087 00
O-117	Ring, retaining	340 0025 00
O-118	Flange, clutch	503 4920 001
O-119	Drum, clutch	504 8667 002
O-120	Bearing, gear clutch	504 8668 002
O-121	Ring, retaining	340 0025 00
O-122	Ring, retaining	340 0025 00
O-123	Shaft, autopositioner	505 5785 002
O-124	Clutch	502 1825 002
O-125	Spring, clutch	502 7029 002
O-126	Spring, clutch	502 7029 002
O-128	Pawl	503 5079 002
O-129	Ring, retaining	340 0087 00
O-130	Gear	504 8675 002
O-143	Hub, coupler	504 9258 002
O-160	Bearing, sleeve	504 9410 00
O-161	Gear, coupler	504 9422 002
O-164	Bearing	309 0132 00
O-165	Bearing	309 0132 00
O-166	Bearing	309 0131 00
O-167	Bearing	309 0131 00
O-168	Bearing	309 0131 00
O-174	Bearing	504 8643 001
O-175	Bearing	309 0115 00
O-176	Bearing	309 0115 00
O-178	Bearing	309 0117 00
O-180	Bearing	309 0117 00
O-187	Bushing	504 9192 001
O-188	Bushing	504 9192 001
O-190	Collar	505 5421 002
O-191	Nut, locking	334 0444 00

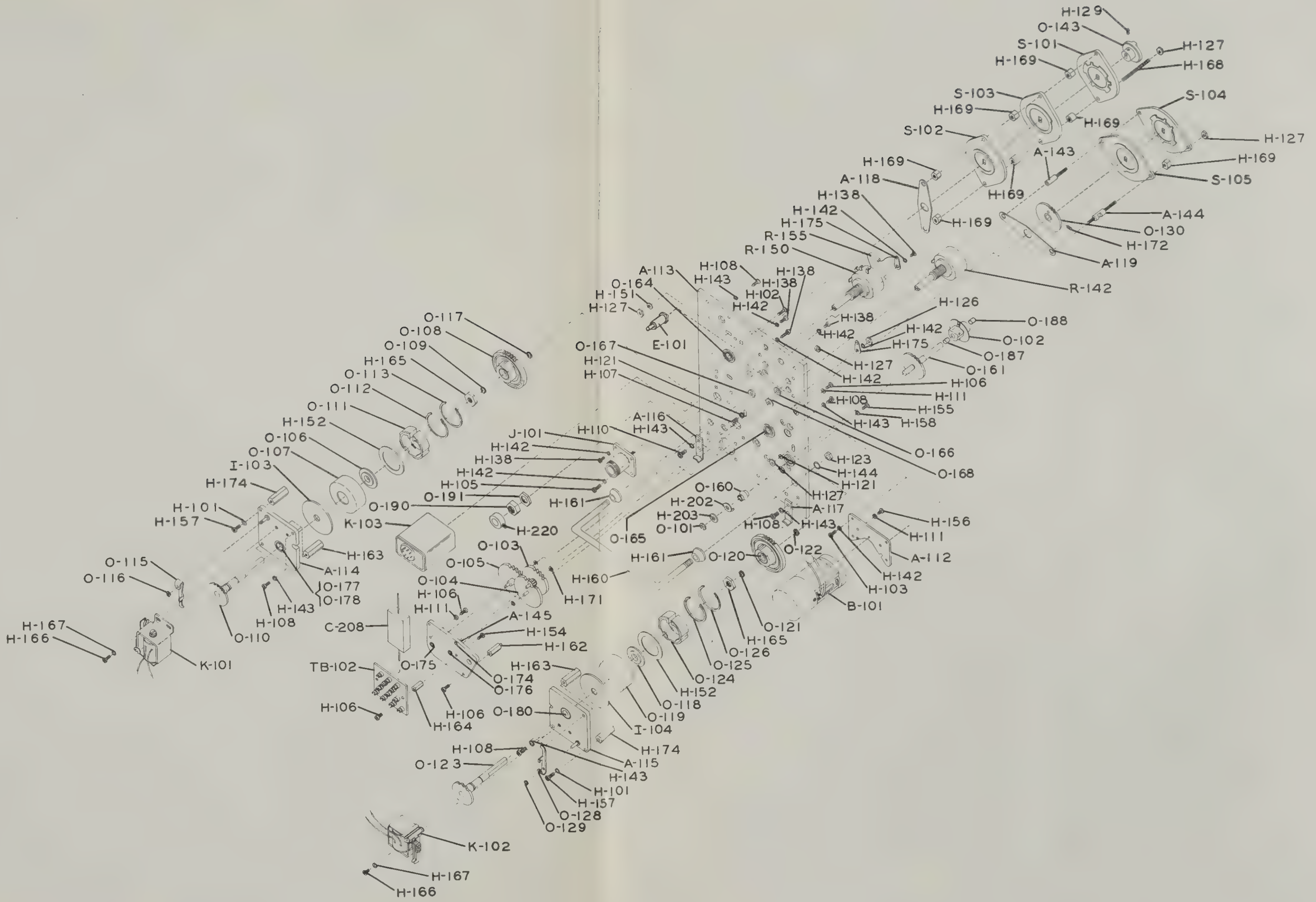
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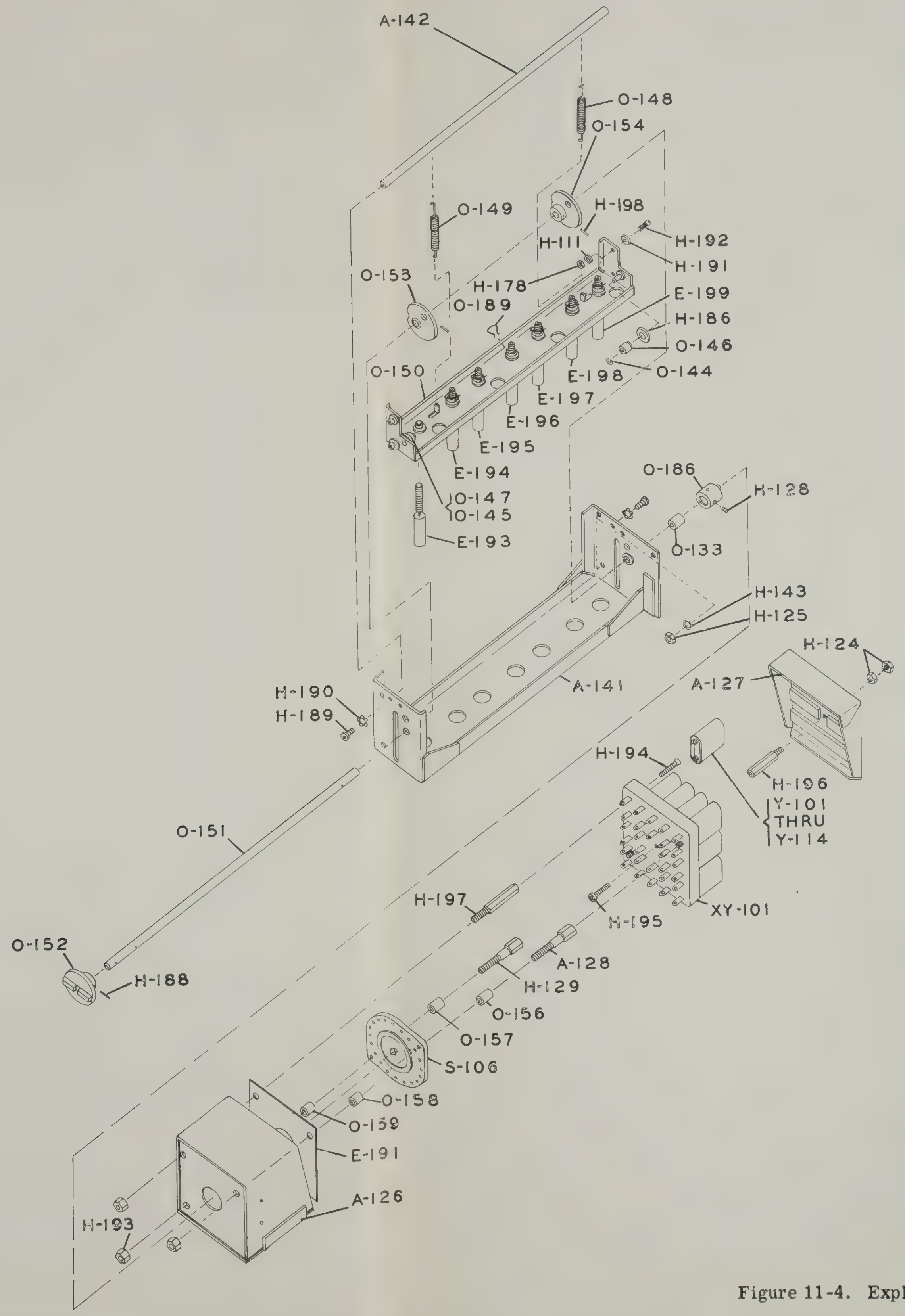
Figure 11-3. Exploded View of Front Panel Identifying Parts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O-151
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XY-101
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A-128
H-188
H-129
O-156
O-157
S-106
O-158
O-159
E-191
A-126
H-193

Reference Symbol	Description	Part Number
A-126	Housing, Coarse Frequency crystal	504 9291 002
A-127	Cover, Coarse Frequency crystal	504 9289 002
A-128	Post, supporting	504 9293 002
A-129	Post, supporting	504 9293 002
A-141	Frame, Coarse Frequency Tuner	505 1480 002
A-142	Post, supporting	504 9252 001
E-191	Plate, insulating	505 1833 001
E-193	Slug assembly	505 2654 002
E-194	Slug assembly	505 2654 002
E-195	Slug assembly	505 2654 002
E-196	Slug assembly	505 2654 002
E-197	Slug assembly	505 2654 002
E-198	Slug assembly	505 2654 002
E-199	Slug assembly	505 2654 002
H-124	Nut, #4-40 Hex	313 0039 00
H-125	Nut, #6-32 Hex	313 0045 00
H-178	Nut, #2-56 Hex	313 0013 00
H-186	Washer, felt	302 0068 00
H-187	Washer, #2 int. tooth lock	373 1010 00
H-188	Pin, taper	311 7010 00
H-189	Screw, #5-40 x 3/16 PBH	343 0007 00
H-190	Washer, #5 ext. tooth lock	373 0040 00
H-191	Washer	504 9254 001
H-192	Pin, guide	504 9263 002
H-193	Post, spacing	500 5958 001
H-194	Screw, #4-40 x 1/2 PFH	342 0284 00
H-195	Screw, #4-40 x 1/2 PBH	343 0426 00
H-196	Post, supporting	504 9276 001
H-197	Post, spacing	504 9277 001
H-198	Pin, taper	311 7003 00
O-133	Bushing	504 9192 001
O-144	Ring, retainer	340 0086 00
O-145	Ring, retainer	340 0086 00
O-146	Roller, cam	504 9262 002
O-147	Roller, cam	504 9262 002
O-148	Spring	504 9211 002
O-149	Spring	504 9211 002
O-150	Table, slug	504 9256 002
O-151	Shaft, cam	504 9255 001
O-152	Hub, coupler	504 9259 002
O-153	Cam	504 9260 002
O-154	Cam	504 9261 002
O-156	Sleeve, insulating	504 9280 001
O-157	Sleeve, insulating	504 9280 001
O-158	Sleeve, insulating	505 1839 001
O-159	Sleeve, insulating	505 1839 001
O-186	Adapter, shaft	504 9425 002
O-189	Spring, lock	504 9210 002

Figure 11-4. Exploded View of Coarse Frequency Tuner Identifying Parts

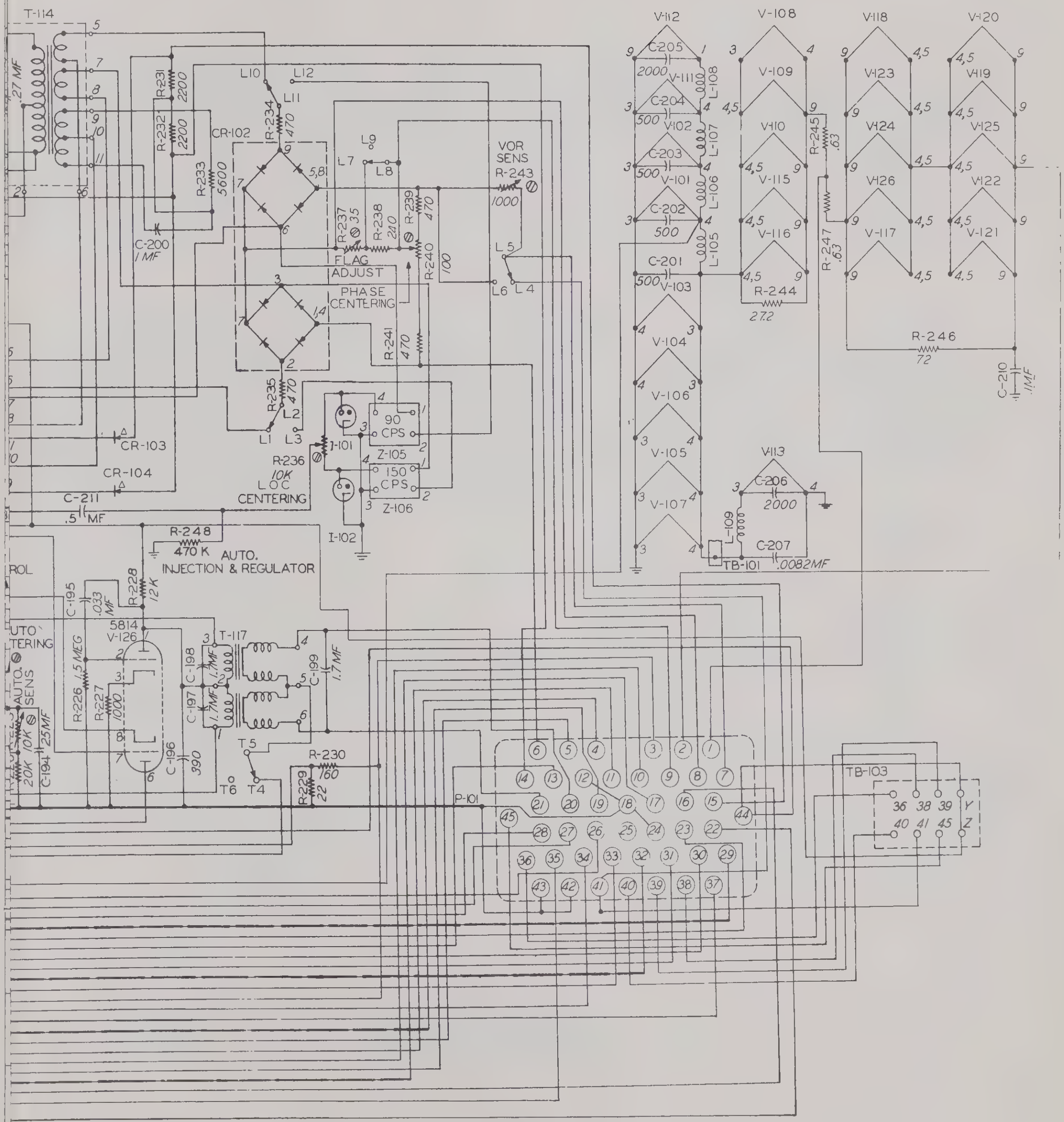
SECTION 12

ILLUSTRATIONS

TO ANODE
CR-103,
IN

NOTE:
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE:
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45.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R-232 2200
R-233 5600
CR-102
C-200 .1 MF
L10
L12
L11
R-234 470
L9
L7
L8
R-237 35
R-238 210
R-239 470
R-240 100
FLAG ADJUST
PHASE CENTERING
VOR SENS
R-243 1000
L5
L6
L4
R-241 470
R-235 470
L2
L1
L3
CR-103
CR-104
C-211 .5 MF
I-101
R-236 10K
LOC CENTERING
90 CPS
Z-105
150 CPS
Z-106
I-102
R-248 470 K
AUTO. INJECTION & REGULATOR
ROL
C-195 .033 MF
R-228 12K
UTO TERING
5814 V-126
R-226 1.5 MEG
R-227 1000
AUTO. SENS
20K
10K
C-194 .25MF
C-196 390
C-198 1.7MF
C-197 1.7MF
T-117
C-199 1.7 MF
T5
T6
T4
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R-229 22
P-101
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40 41 45 Z
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V-122
V-121
R-246 72
C-210 .1MF

Figure 12-1A. 51R-3 Navigation Receiver, Schematic Diagram

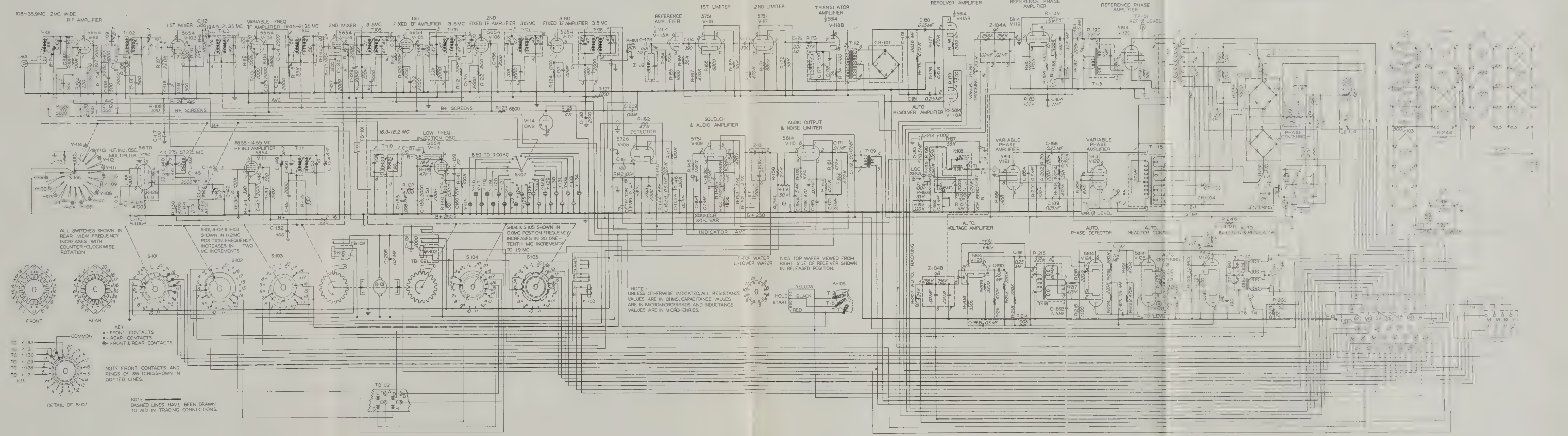
SECTION 12

ILLUSTRATIONS

△ POSITIVE VOLTAGE APPLIED TO ANODE (DESIGNATED BY ARROW) OF CR-103, CR-104, AND CR-105 RESULTS IN FORWARD CURRENT

NOTE
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45


108-135.9MC 2MC WIDE
R.F. AMPLIFIER
1ST MIXER
VARIABLE FREQ. IF AMPLIFIER 19.45-21.35 MC
2ND MIXER
1ST FIXED IF AMPLIFIER 3.15MC
2ND FIXED IF AMPLIFIER 3.15MC
3RD FIXED IF AMPLIFIER 3.15MC
REFERENCE AMPLIFIER
1ST LIMITER
2ND LIMITER
TRANSLATOR AMPLIFIER
MANUAL RESOLVER AMPLIFIER
REFERENCE PHASE AMPLIFIER
AUTO RESOLVER AMPLIFIER
H.F. INJ. OSC. MULTIPLIER
HF INJ. AMPLIFIER
LOW FREQ INJECTION OSC.
8150 TO 9100KC
DETECTOR
SQUELCH & AUDIO AMPLIFIER
AUDIO OUTPUT & NOISE LIMITER
VARIABLE PHASE AMPLIFIER
AUTO. VOLTAGE AMPLIFIER
AUTO. PHASE DETECTOR
AUTO. REACTOR CONT.
B+ SCREENS
AVC
SQUELCH 30~ VAR
INDICATOR AVC
S-101
S-102
S-103
S-104
S-105
FRONT
REAR
KEY
○ - FRONT CONTACTS
● - REAR CONTACTS
◉ - FRONT & REAR CONTACTS
COMMON
DETAIL OF S-107
TB-102
K-105
HOLD
START
YELLOW
BLACK
RED

ALL SWITCHES SHOWN IN REAR VIEW. FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION

S-101, S-102 & S-103 SHOWN IN 112MC POSITION. FREQUENCY INCREASES IN TWO MC INCREMENTS

S-104 & S-105 SHOWN IN 0.0MC POSITION FREQUENCY INCREASES IN 20 ONE-TENTH-MC INCREMENTS TO 1.9 MC.

NOTE: FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES.

NOTE
DASHED LINES HAVE BEEN DRAWN TO AID IN TRACING CONNECTIONS.

NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.

T-TOP WAFER
L-LOWER WAFER

K105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION.

Figure 12-1A. 51R-3 Navigation Receiver, Schematic Diagram

TO ANODE
CR-103,
S IN

NOTE
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE:
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45.

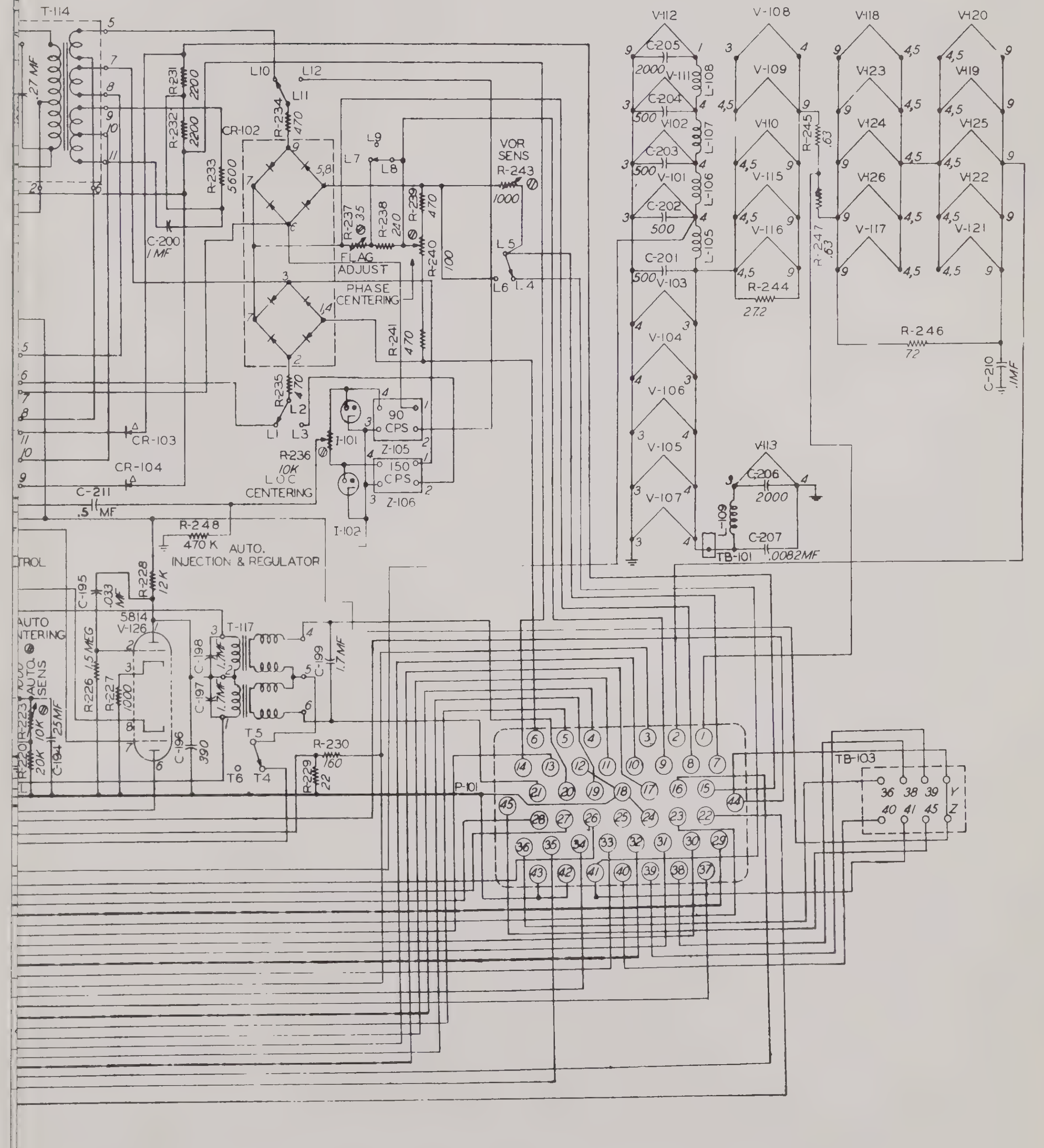

T-114
.27 MF
R-231 2200
R-232 2200
R-233 5600
CR-102
C-200 1 MF
L10
L12
L11
R-234 470
L9
L7
L8
VOR SENS
R-243 1000
R-237 35
R-238 210
R-239 470
R-240 100
FLAG ADJUST
PHASE CENTERING
L5
L6
L4
R-241 470
R-235 470
L1 L2 L3
I-101
90 CPS
Z-105
150 CPS
Z-106
I-102
R-236 10K
LOC CENTERING
CR-103
CR-104
C-211 .5 MF
R-248 470 K
AUTO. INJECTION & REGULATOR
TROL
C-195 .033 MF
R-228 12K
AUTO
NTERING
5814 V-126
R-226 1.5 MEG
R-227 1000
AUTO. SENS
R-223 10K
R-220 20K
C-194 .25 MF
C-196 390
T-117
C-198 1.7 MF
C-197 1.7 MF
C-199 1.7 MF
T5 T6 T4
R-230 160
R-229 22
P-101
V-112
C-205 2000
V-111
L-108
C-204 500
V-102
L-107
C-203 500
V-101
L-106
C-202 500
L-105
C-201 500
V-103
V-104
V-106
V-105
V-107
V-108
V-109
V-110
V-115
V-116
R-245 .63
R-244 27.2
R-247 .63
V-118
V-123
V-124
V-126
V-117
V-120
V-119
V-125
V-122
V-121
R-246 72
C-210 .1 MF
V-113
C-206 2000
L-109
C-207 .0082 MF
TB-101
TB-103
36 38 39 Y
40 41 45 Z

Figure 12-1C. 51R-3 Navigation Receiver, Schematic Diagram, Serial No. 2401 and above

51R-3 NAVIGATION RECEIVER

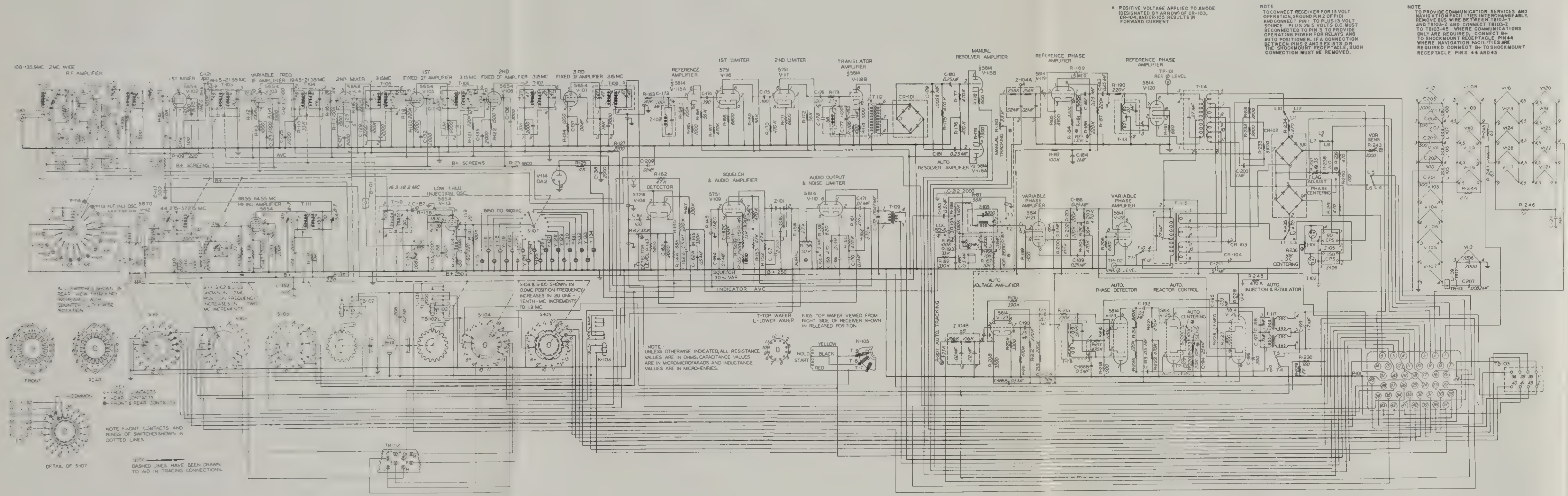
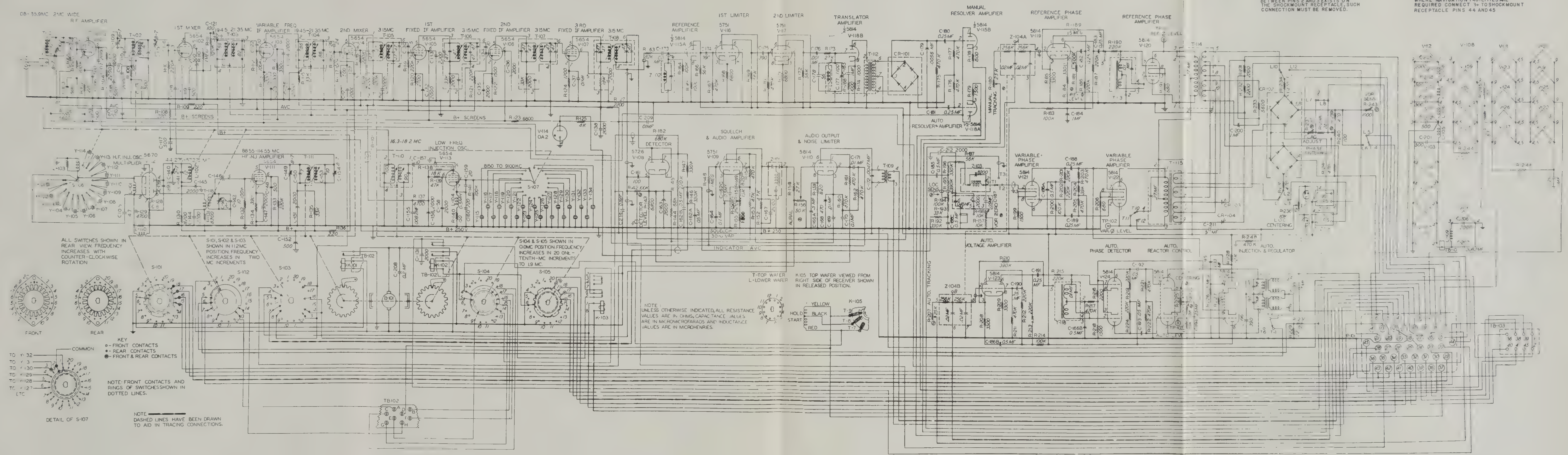

Δ POSITIVE VOLTAGE APPLIED TO ANODE (DESIGNATED BY ARROW) OF CR-103, CR-104, AND CR-105 RESULTS IN FORWARD CURRENT
NOTE
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.
NOTE
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45
108-135.9MC 2MC WIDE R.F. AMPLIFIER
1ST MIXER
VARIABLE FREQ IF AMPLIFIER 19.45-21.35 MC
2ND MIXER
1ST FIXED IF AMPLIFIER 3.15MC
2ND FIXED IF AMPLIFIER 3.15MC
3RD FIXED IF AMPLIFIER 3.15 MC
REFERENCE AMPLIFIER
1ST LIMITER
2ND LIMITER
TRANSLATOR AMPLIFIER
MANUAL RESOLVER AMPLIFIER
REFERENCE PHASE AMPLIFIER
REFERENCE PHASE AMPLIFIER
TP-101 REF Ø LEVEL
AUTO RESOLVER AMPLIFIER
B+ SCREENS
AVC
V-113 H.F. INJ OSC MULTIPLIER
44.275-57.275 MC
88.55-114.55 MC HF INJ AMPLIFIER
16.3-18.2 MC
LOW FREQ. INJECTION OSC.
8150 TO 9100KC
DETECTOR
SQUELCH & AUDIO AMPLIFIER
AUDIO OUTPUT & NOISE LIMITER
VARIABLE PHASE AMPLIFIER
VARIABLE PHASE AMPLIFIER
LOC SENS
VOR ZERO
TP-102 VAR Ø LEVEL
FLAG ADJUST
PHASE CENTERING
LOC CENTERING
VOR SENS
AUTO VOLTAGE AMPLIFIER
AUTO. PHASE DETECTOR
AUTO. REACTOR CONTROL
AUTO. INJECTION & REGULATOR
AUTO CENTERING
AUTO. TRACKING
SQUELCH 30∼ VAR
B+ 250
INDICATOR AVC
B+ 250 V
S-104 & S-105 SHOWN IN 0.0MC POSITION FREQUENCY INCREASES IN 20 ONE-TENTH-MC INCREMENTS TO 1.9 MC.
ALL SWITCHES SHOWN IN REAR VIEW FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION
S-101, S-102 & S-103 SHOWN IN 2MC POSITION FREQUENCY INCREASES IN TWO MC INCREMENTS
FRONT
REAR
KEY
○ - FRONT CONTACTS
● - REAR CONTACTS
● - FRONT & REAR CONTACTS
COMMON
DETAIL OF S-107
NOTE FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES.
NOTE
DASHED LINES HAVE BEEN DRAWN TO AID IN TRACING CONNECTIONS.
NOTE
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.
T-TOP WAFER
L-LOWER WAFER
K-105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION.
K-105
YELLOW
BLACK
RED
HOLD
START
K-103
TB-101
TB-102
TB-103
S-104
S-105

Figure 12-1B. 51R-3 Navigation Receiver (Serials 1696 and above), Schematic Diagram

Figure 12-1B. 51R-3 Navigation Receiver (Serials 1696 and above), Schematic Diagram


108-35.9MC 2MC WIDE
R.F. AMPLIFIER
1ST MIXER
VARIABLE FREQ IF AMPLIFIER 19.45-21.35MC
2ND MIXER
3.15MC
1ST FIXED IF AMPLIFIER
2ND FIXED IF AMPLIFIER
3RD FIXED IF AMPLIFIER
REFERENCE AMPLIFIER
1ST LIMITER
2ND LIMITER
TRANSLATOR AMPLIFIER
MANUAL RESOLVER AMPLIFIER
REFERENCE PHASE AMPLIFIER
REFERENCE PHASE AMPLIFIER
AUTO RESOLVER AMPLIFIER
AVC
B+ SCREENS
HIG. H.F. INJ. OSC. MULTIPLIER
88.55-114.55 MC HF INJ AMPLIFIER
16.3-18.2 MC
LOW FREQ. INJECTION OSC.
8150 TO 9100KC
DETECTOR
SQUELCH & AUDIO AMPLIFIER
AUDIO OUTPUT & NOISE LIMITER
VARIABLE PHASE AMPLIFIER
VARIABLE PHASE AMPLIFIER
AUTO. VOLTAGE AMPLIFIER
AUTO. PHASE DETECTOR
AUTO. REACTOR CONTROL
AUTO. INJECTION & REGULATOR
CENTERING
INDICATOR AVC
B+ 250V
S-101
S-102
S-103
S-104
S-105
S-107
TB-101
TB-102
TB-103
K-103
K-105
YELLOW
BLACK
RED
HOLD
START
FRONT
REAR
DETAIL OF S-107
COMMON
TO Y-32
TO Y-3
TO Y-130
TO Y-29
TO Y-128
TO Y-127
ETC

△ POSITIVE VOLTAGE APPLIED TO ANODE (DESIGNATED BY ARROW) OF CR-103, CR-104, AND CR-105 RESULTS IN FORWARD CURRENT

NOTE
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D C MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44 WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45

ALL SWITCHES SHOWN IN REAR VIEW. FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION

S-101, S-102 & S-103 SHOWN IN 112MC POSITION. FREQUENCY INCREASES IN TWO MC INCREMENTS

S-104 & S-105 SHOWN IN 0.0MC POSITION. FREQUENCY INCREASES IN 20 ONE-TENTH-MC INCREMENTS TO 1.9 MC

KEY
○- FRONT CONTACTS
•- REAR CONTACTS
●- FRONT & REAR CONTACTS

NOTE: FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES.

NOTE ▬ ▬ ▬
DASHED LINES HAVE BEEN DRAWN TO AID IN TRACING CONNECTIONS.

T-TOP WAFER
L-LOWER WAFER

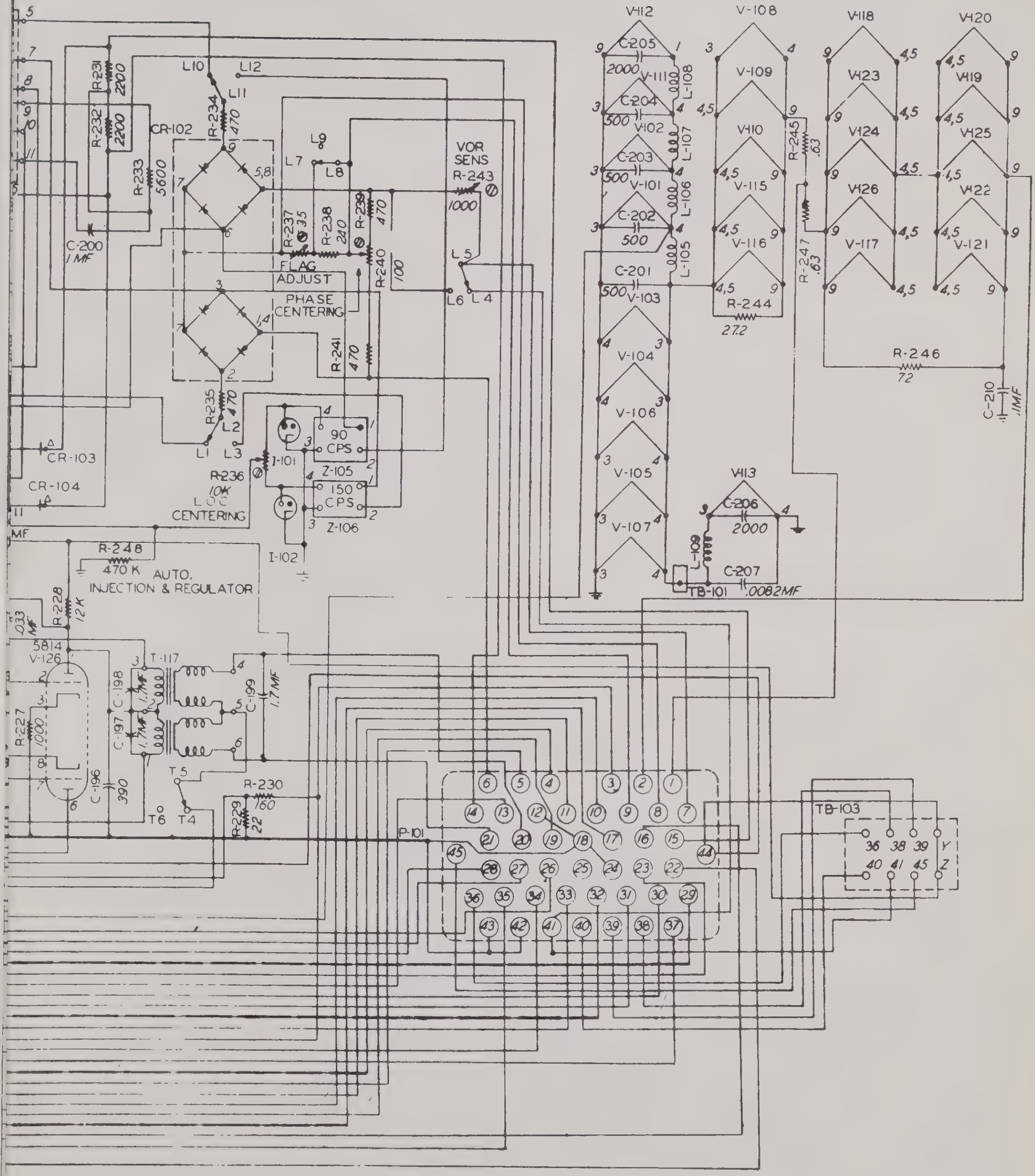
K105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION.

NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.

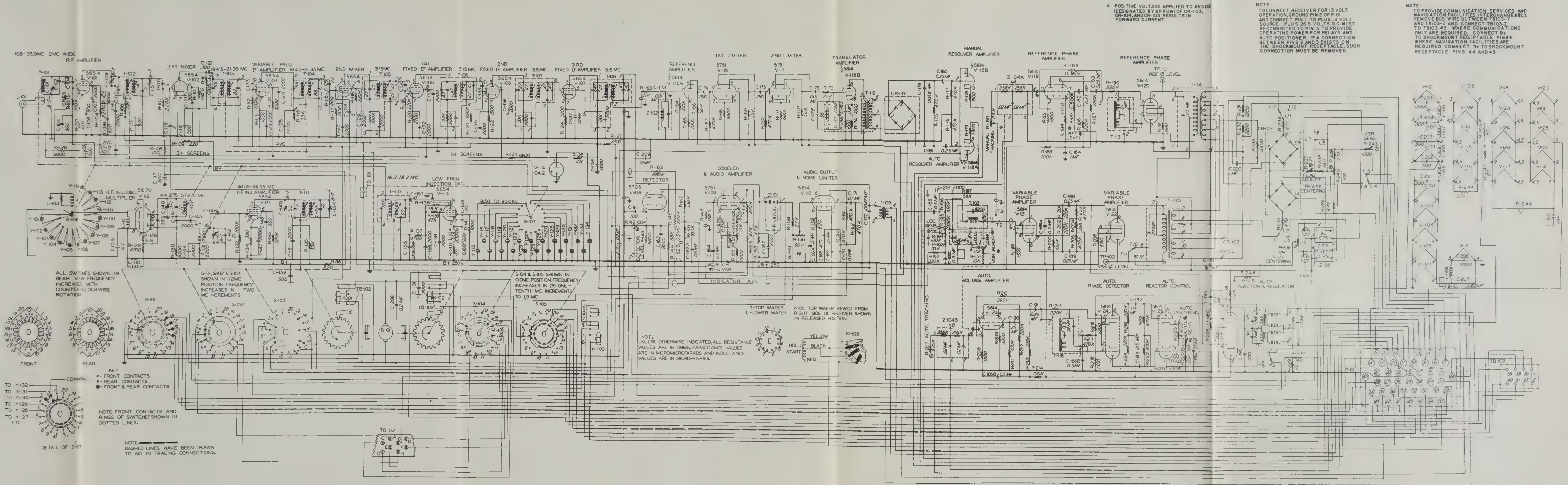
Figure 12-1C. 51R-3 Navigation Receiver, Schematic Diagram, Serial No. 2401 and above

NOTE:
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE:
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45.


L10
L12
L11
R-234 470
R-231 2200
R-232 2200
R-233 5600
CR-102
C-200 1MF
L9
L7
L8
VOR SENS
R-243 1000
R-237 35
R-238 240
R-239 470
R-240 100
FLAG ADJUST
PHASE CENTERING
L5
L6
L4
R-241 470
R-235 470
L1
L2
L3
CR-103
CR-104
R-236 10K
LOC CENTERING
I-101
I-102
90 CPS
Z-105
150 CPS
Z-106
R-248 470 K
AUTO. INJECTION & REGULATOR
R-228 12K
5814 V-126
R-227 1000
C-196 390
C-197 1.7MF
C-198 1.7MF
T-117
C-199 1.7MF
T5
T6
T4
R-230 160
R-229 22
P-101
V-112
C-205 2000
V-111
L-108
C-204 500
V-102
L-107
C-203 500
V-101
L-106
C-202 500
L-105
C-201 500
V-103
V-104
V-106
V-105
V-107
V-108
V-109
V-110
V-115
V-116
R-244 27.2
R-245 .63
R-247 .63
V-118
V-123
V-124
V-126
V-117
V-120
V-119
V-125
V-122
V-121
R-246 72
C-210 .1MF
V-113
C-206 2000
L-109
C-207 .0082MF
TB-101
TB-103
36 38 39 Y
40 41 45 Z

12-1D. 51R-3 Navigation Receiver, Schematic Diagram, Serial No. 3821 and above


108-135.9MC 2MC WIDE
R F AMPLIFIER
1ST MIXER
VARIABLE FREQ IF AMPLIFIER 19.45-21.35 MC
2ND MIXER
1ST FIXED IF AMPLIFIER 3.15MC
2ND FIXED IF AMPLIFIER 3.15MC
3 RD FIXED IF AMPLIFIER 3.15 MC
REFERENCE AMPLIFIER
1ST LIMITER
2ND LIMITER
TRANSLATOR AMPLIFIER
MANUAL RESOLVER AMPLIFIER
REFERENCE PHASE AMPLIFIER
REFERENCE PHASE AMPLIFIER
TP-101 REF Ø LEVEL
AUTO RESOLVER AMPLIFIER
AVC
B+ SCREENS
H.F. INJ. OSC MULTIPLIER
88.55-114.55 MC HF INJ. AMPLIFIER
16.3-18.2 MC
LOW FREQ INJECTION OSC.
DETECTOR
SQUELCH & AUDIO AMPLIFIER
AUDIO OUTPUT & NOISE LIMITER
VARIABLE PHASE AMPLIFIER
VARIABLE PHASE AMPLIFIER
PHASE CENTERING
FLAG ADJUST
VOR SENS
INDICATOR AVC
AUTO. VOLTAGE AMPLIFIER
AUTO. PHASE DETECTOR
AUTO. REACTOR CONTROL
AUTO. INJECTION & REGULATOR
AUTO LEVEL
S-101
S-102
S-103
S-104
S-105
TB-101
TB-102
TB-103
K-103
K-105
FRONT
REAR
DETAIL OF S-107
TO Y-132
TO Y-131
TO Y-130
TO Y-129
TO Y-128
TO Y-127
ETC.
COMMON
HOLD
START
YELLOW
BLACK
RED

△ POSITIVE VOLTAGE APPLIED TO ANODE (DESIGNATED BY ARROW) OF CR-103, CR-104, AND CR-105 RESULTS IN FORWARD CURRENT.

NOTE:
TO CONNECT RECEIVER FOR 13 VOLT OPERATION, GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C. MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTO POSITIONER. IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED.

NOTE:
TO PROVIDE COMMUNICATION SERVICES AND NAVIGATION FACILITIES INTERCHANGEABLY, REMOVE BUS WIRE BETWEEN TB103-Y AND TB103-Z AND CONNECT TB103-Z TO TB103-45. WHERE COMMUNICATIONS ONLY ARE REQUIRED, CONNECT B+ TO SHOCKMOUNT RECEPTACLE PIN 44. WHERE NAVIGATION FACILITIES ARE REQUIRED CONNECT B+ TO SHOCKMOUNT RECEPTACLE PINS 44 AND 45

ALL SWITCHES SHOWN IN REAR VIEW. FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION

S-101, S-102 & S-103 SHOWN IN 112MC POSITION. FREQUENCY INCREASES IN TWO MC INCREMENTS

S-104 & S-105 SHOWN IN 0.0MC. POSITION. FREQUENCY INCREASES IN 20 ONE-TENTH-MC. INCREMENTS TO 1.9 MC.

KEY
○- FRONT CONTACTS
●- REAR CONTACTS
⬤- FRONT & REAR CONTACTS

NOTE: FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES.

NOTE: DASHED LINES HAVE BEEN DRAWN TO AID IN TRACING CONNECTIONS.

NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.

T-TOP WAFER
L-LOWER WAFER

K-105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION.

Figure 12-1D. 51R-3 Navigation Receiver, Schematic Diagram, Serial No. 3821 and above

HOOK-UP WIRE CODE

The characteristics of the hook-up wire used in this equipment are indicated by groups of symbols on the diagrams. Each symbol group consists of a maximum of three letters followed by a maximum of three numerals. When three letters are used the first indicates the type of wire, the second represents the size of wire, and the third is the letter "S", used only when the wire is shielded. When two letters are used, the first and second letters indicate either the type and size of wire or the size of wire and shielding, respectively. When one letter is used it indicates the wire size only. The first numeral indicates the color of the wire body and the second and third numerals, if any, represent the colors of tracers, all numerals being in accordance with the standard RTMA and JAN-C-76 color code.

The symbols are assigned according to the following table.

FIRST LETTER	TYPE OF WIRE
A	Cotton Braid Over Plastic (Formerly AN-J-C-48)
B	Busbar, Round Tinned
C	Jan Type WL(600 Volts)
D	Miniature Jan Wire
E	
F	Extra Flexible Varnished Cambric
G	General Electric Deltabeston
H	KEL-F (Monochlorotrifluoroethylene)
J	
K	Neon Sign Cable (15,000 Volts)
L	Silicone
M	
N	Single Conductor Stranded (Not Rubber Covered)
P	Single Conductor Stranded (Rubber Covered)
Q	
R	Jan Type SRIR(1000 Volts)
T	Teflon (Polytetrafluoroethylene)
V	Jan Type SRHV (2500 Volts)
W	
X	
Y	
Z	

SECOND LETTER	AWG# WIRE SIZE
A	#22
B	#20
C	#18
D	#16
E	#14
F	#12
G	#10
H	#8
J	#6
K	#4
L	#2
M	#1
N	#0
P	#00
Q	#000
R	#0000
T	#28
V	#26
W	
X	
Y	
Z	

THIRD LETTER	
S	Shielded
None	Unshielded

NUMBER OR LETTER	BODY OR TRACER COLOR
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray (Slate)
9	White
a	Clear
b	Tan
c	Pink
d	Maroon
e	Light Green
f	Light Blue

EXAMPLES

UNSHIELDED WIRE, JAN TYPE WL, #22AWG, WHITE WITH RED AND GREEN TRACERS:

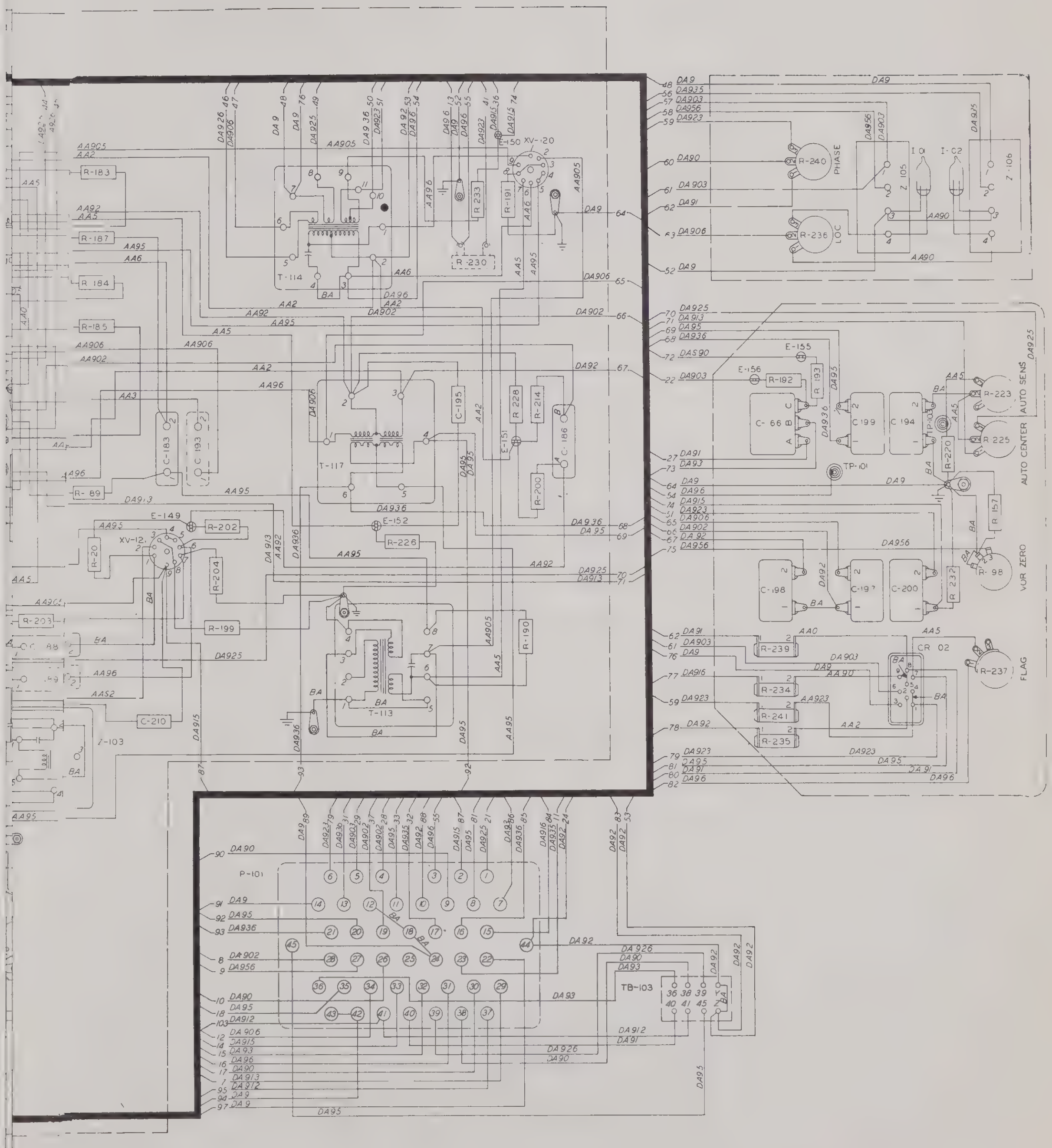
C	A	9	25		4 1/4
Type of Wire	Size of Wire	Color of Body	Color of Tracers	--	Length of Wire in Inches (Includes Stripping & Tinning)

SHIELDED WIRE (SINGLE), JAN TYPE SPIR, #16AWG, WHITE WITH RED AND GREEN TRACERS:

R	D	S	9	25		4 1/4
Type of Wire	Size of Wire	Shielded	Color of Body	Color of Tracers	--	Length of Wire in Inches (Includes Stripping & Tinning)

SHIELDED WIRE (MULTIPLE), MINIATURE JAN, #22AWG, WHITE, AND WHITE WITH RED TRACER:

D	A	S	(9)	(92)		4 1/4
Type of Wire	Size of Wire	Shielded	First Conductor	Second Conductor	--	Length of Wire in Inches (Includes Stripping & Tinning)


R-183
R-187
R 184
R-185
C-183
C 193
R-89
E-149
XV-12
R-20
R-202
R-204
R-203
R-199
C-210
Z-103
T-114
E-150
XV-120
R 233
R-191
R 230
T-117
C-195
R 228
R-214
C-186
E-151
R-200
E-152
R-226
T-113
R-190
PHASE
R-240
R-236
LOC
Z 105
I-01
I-02
Z-106
E-155
E-156
R-192
R 193
C-66
C 199
C 194
TP-103
R-223
AUTO SENS
R 225
AUTO CENTER
R-220
TP-101
R 157
R-98
VOR ZERO
C-198
C-197
C-200
R 232
R-239
R-234
R-241
R-235
CR 02
R-237
FLAG
P-101
TB-103

12-2A. 51R-3 Navigation Receiver, Practical Wiring Diagram (Wires have Tracer color)

HOOK-UP WIRE CODE

The characteristics of the hook-up wire used in this equipment are indicated by groups of symbols on the diagrams. Each symbol group consists of a maximum of three letters followed by a maximum of three numerals. When three letters are used the first indicates the type of wire, the second represents the size of wire, and the third is the letter "S", used only when the wire is shielded. When two letters are used, the first and second letters indicate either the type and size of wire or the size of wire and shielding, respectively. When one letter is used it indicates the wire size only. The first numeral indicates the color of the wire body and the second and third numerals, if any, represent the colors of tracers, all numerals being in accordance with the standard RTMA and JAN-C-76 color code.

The symbols are assigned according to the following table.

FIRST LETTER	TYPE OF WIRE
A	Cotton Braid Over Plastic (Formerly AN-J-C-48)
B	Busbar, Round Tinned
C	Jan Type WL(600 Volts)
D	Miniature Jan Wire
E	
F	Extra Flexible Varnished Cambric
G	General Electric Deltabeston
H	KEL-F (Monochlorotrifluoroethylene)
J	
K	Neon Sign Cable (15,000 Volts)
L	Silicone
M	
N	Single Conductor Stranded (Not Rubber Covered)
P	Single Conductor Stranded (Rubber Covered)
Q	
R	Jan Type SRIR(1000 Volts)
T	Teflon (Polytetrafluoroethylene)
V	Jan Type SRHV (2500 Volts)
W	
X	
Y	
Z	

SECOND LETTER	AWG# WIRE SIZE
A	#22
B	#20
C	#18
D	#16
E	#14
F	#12
G	#10
H	#8
J	#6
K	#4
L	#2
M	#1
N	#0
P	#00
Q	#000
R	#0000
T	#28
V	#26
W	
X	
Y	
Z	

THIRD LETTER	
S	Shielded
None	Unshielded

NUMBER OR LETTER	BODY OR TRACER COLOR
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray (Slate)
9	White
a	Clear
b	Tan
c	Pink
d	Maroon
e	Light Green
f	Light Blue

EXAMPLES

UNSHIELDED WIRE, JAN TYPE WL, #22AWG, WHITE WITH RED AND GREEN TRACERS:

C	A	9	25		4 1/4
Type of Wire	Size of Wire	Color of Body	Color of Tracers	--	Length of Wire in Inches (Includes Stripping & Tinning)

SHIELDED WIRE (SINGLE), JAN TYPE SPIR, #16AWG, WHITE WITH RED AND GREEN TRACERS:

R	D	S	9	25		4 1/4
Type of Wire	Size of Wire	Shielded	Color of Body	Color of Tracers	--	Length of Wire in Inches (Includes Stripping & Tinning)

SHIELDED WIRE (MULTIPLE), MINIATURE JAN, #22AWG, WHITE, AND WHITE WITH RED TRACER:

D	A	S	(9)	(92)		4 1/4
Type of Wire	Size of Wire	Shielded	First Conductor	Second Conductor	--	Length of Wire in Inches (Includes Stripping & Tinning)

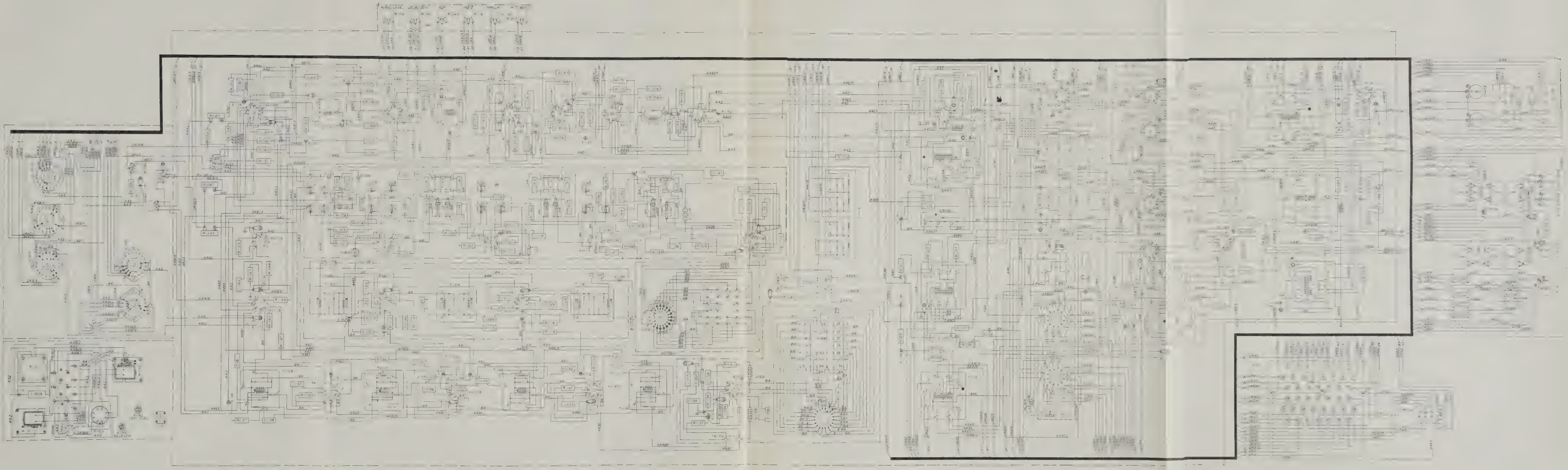
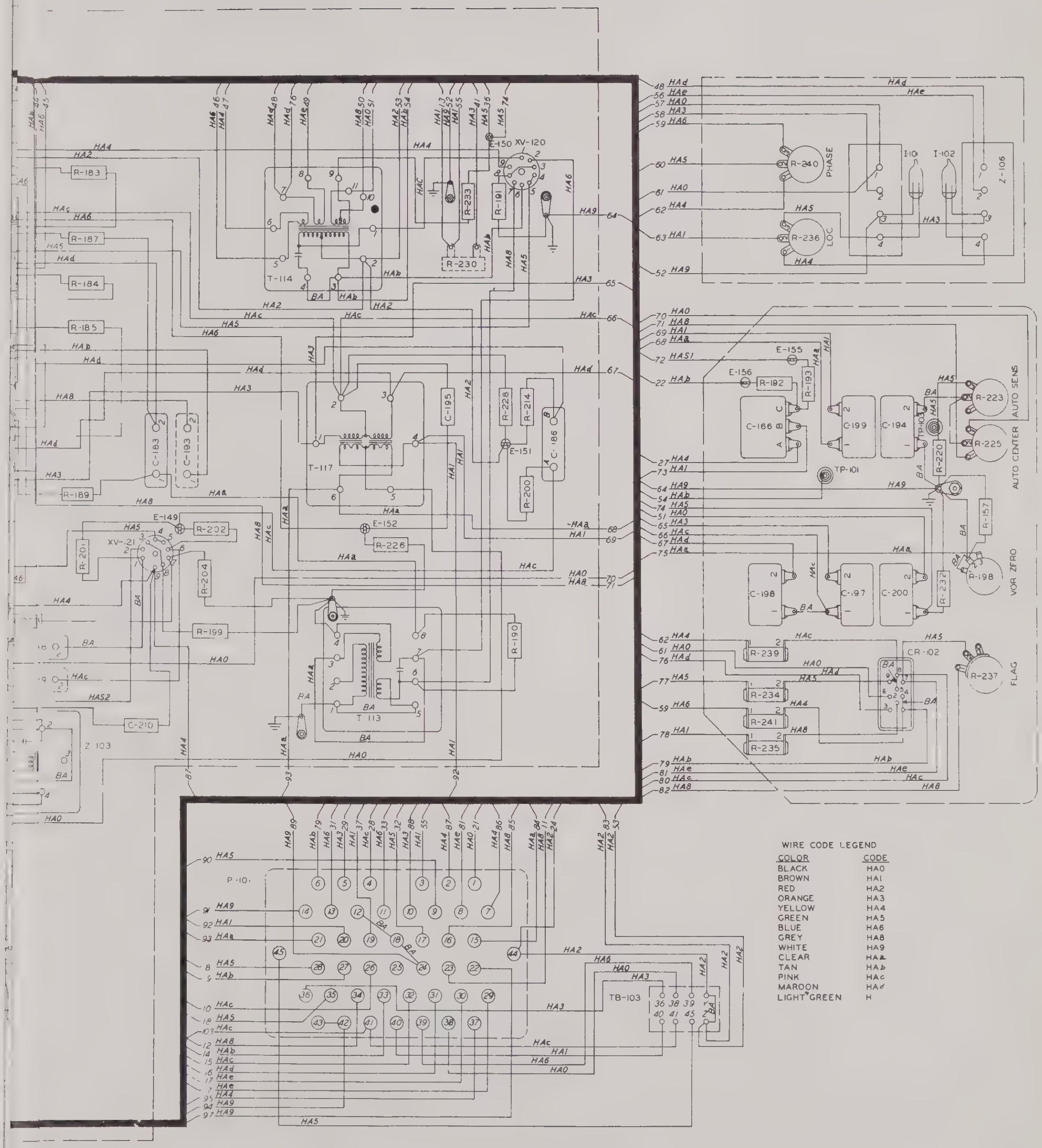


Figure 12-2A. 51R-3 Navigation Receiver, Practical Wiring Diagram (Wires have Tracer color)


T-114
XV-120
E-150
R-233
R-191
R-230
R-183
R-187
R-184
R-185
C-183
C-193
R-189
T-117
C-195
R-228
R-214
C-186
E-151
R-200
E-149
R-202
XV-21
R-201
R-204
E-152
R-226
R-199
T 113
R-190
C-210
Z 103
P-101
TB-103
R-240
PHASE
I-101
I-102
Z-106
R-236
LOC
E-155
E-156
R-192
R-193
C-166
C-199
C-194
TP-103
R-223
AUTO SENS
R-225
AUTO CENTER
TP-101
R-220
R-157
R-198
VOR ZERO
C-198
C-197
C-200
R-232
R-239
CR-102
R-237
FLAG
R-234
R-241
R-235

WIRE CODE LEGEND

COLOR	CODE
BLACK	HA0
BROWN	HA1
RED	HA2
ORANGE	HA3
YELLOW	HA4
GREEN	HA5
BLUE	HA6
GREY	HA8
WHITE	HA9
CLEAR	HAa
TAN	HAb
PINK	HAc
MAROON	HAd
LIGHT GREEN	H

R-3 Navigation Receiver, Practical Wiring Diagram (Wires have no Tracer color)

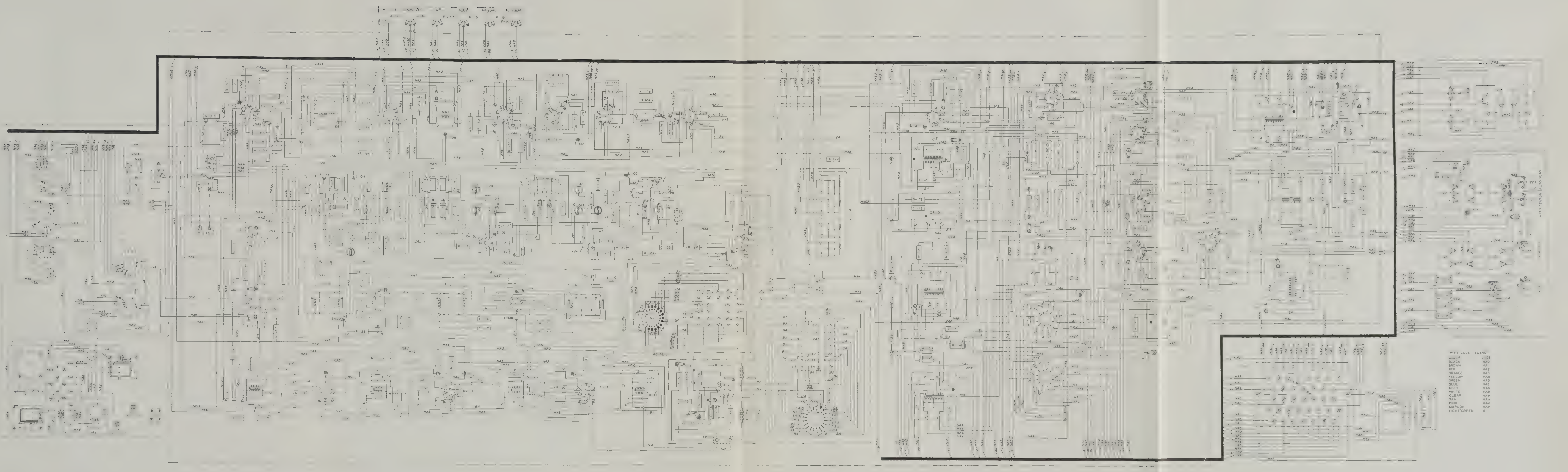

WIRE CODE LEGEND
COLOR
CODE
BLACK HA0
BROWN HA1
RED HA2
ORANGE HA3
YELLOW HA4
GREEN HA5
BLUE HA6
GREY HA8
WHITE HA9
CLEAR HAa
TAN HAb
PINK HAc
MAROON HAd
LIGHT GREEN H

Figure 12-2B. 51R-3 Navigation Receiver, Practical Wiring Diagram (Wires have no Tracer color)

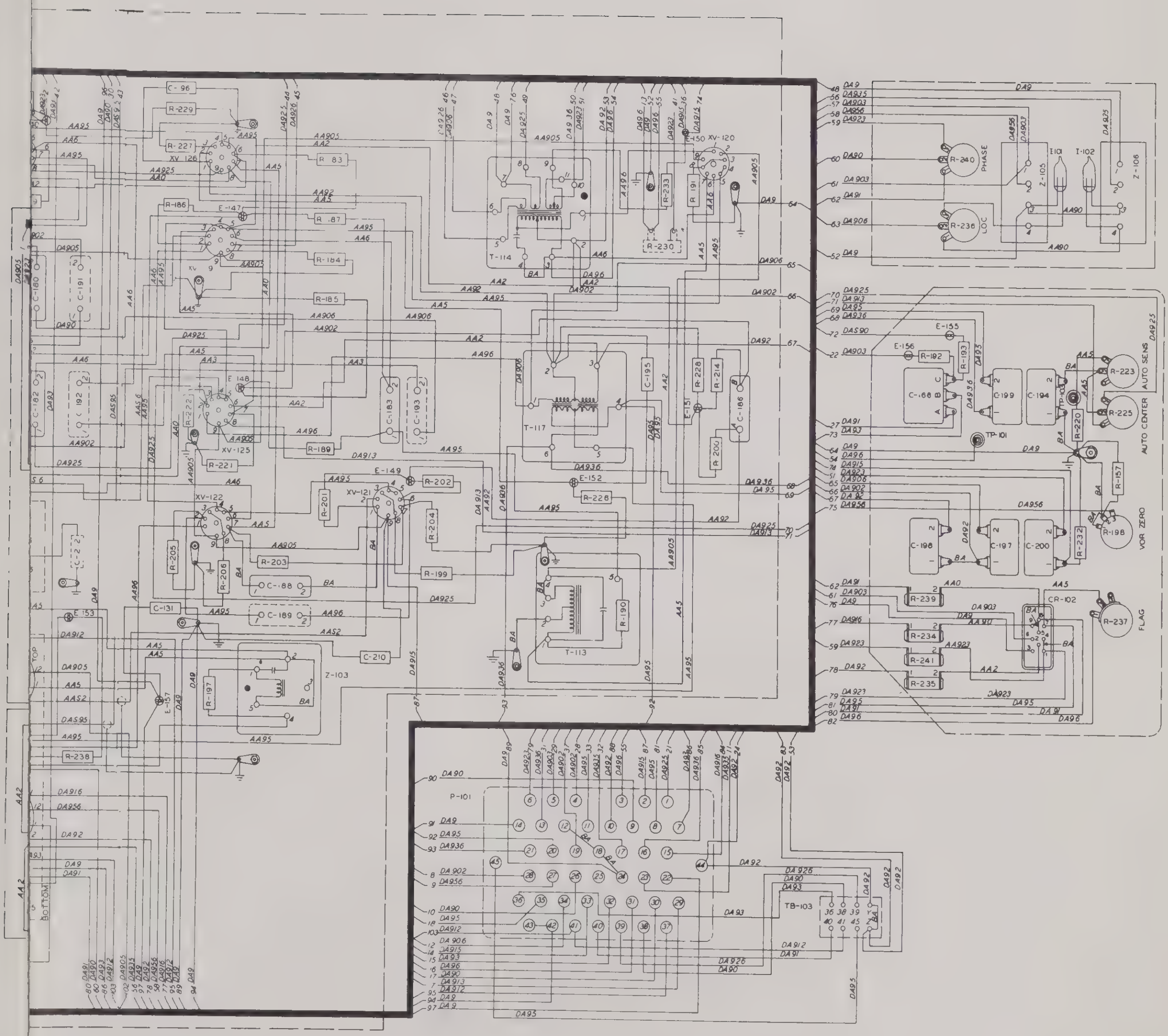

XV-126
XV-125
XV-122
XV-121
XV-120
XV
E-147
E-148
E-149
E-150
E-151
E-152
E-153
E-155
E-156
E-157
T-114
T-117
T-113
Z-103
Z-105
Z-106
P-101
TB-103
CR-102
TP-101
TP-103
I-101
I-102
PHASE
LOC
AUTO CENTER
AUTO SENS
VOR ZERO
FLAG
TOP
BOTTOM
C-96
C-131
C-180
C-182
C-183
C-186
C-188
C-189
C-191
C-192
C-193
C-194
C-195
C-196
C-197
C-198
C-199
C-200
C-210
R-83
R-87
R-157
R-184
R-185
R-186
R-189
R-190
R-191
R-192
R-193
R-197
R-198
R-199
R-200
R-201
R-202
R-203
R-204
R-205
R-208
R-214
R-220
R-221
R-222
R-223
R-225
R-226
R-227
R-228
R-229
R-230
R-232
R-233
R-234
R-235
R-236
R-237
R-238
R-239
R-240
R-241

Figure 12-2C. 51R-3 Navigation Receiver Practical Wiring Diagram (Serials 1696 and above) Wires have Tracer Color

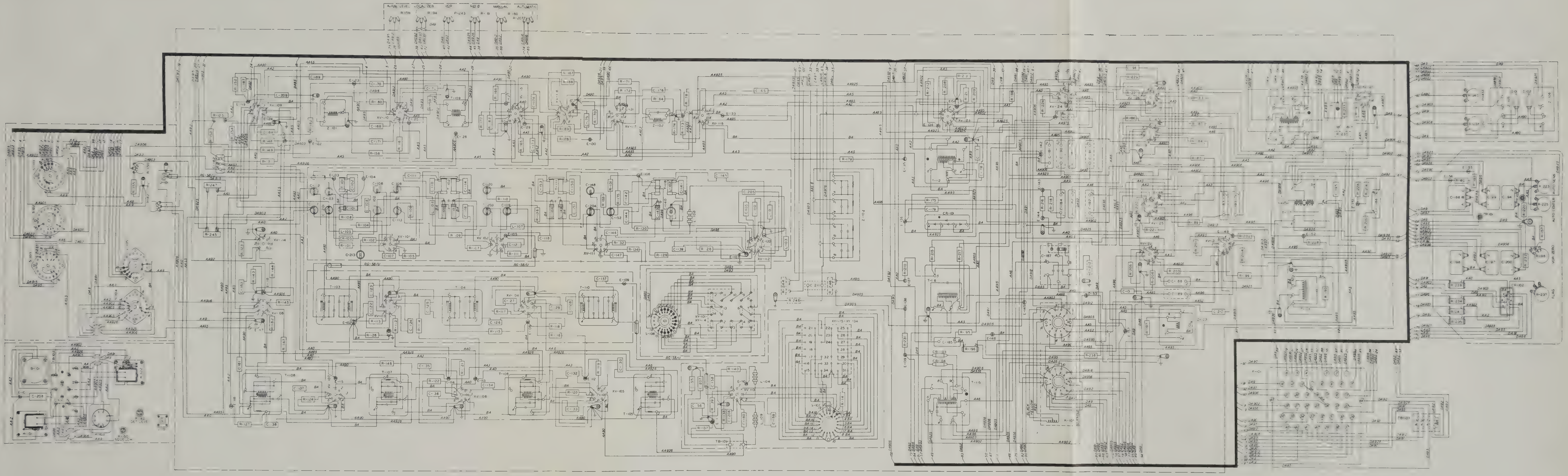
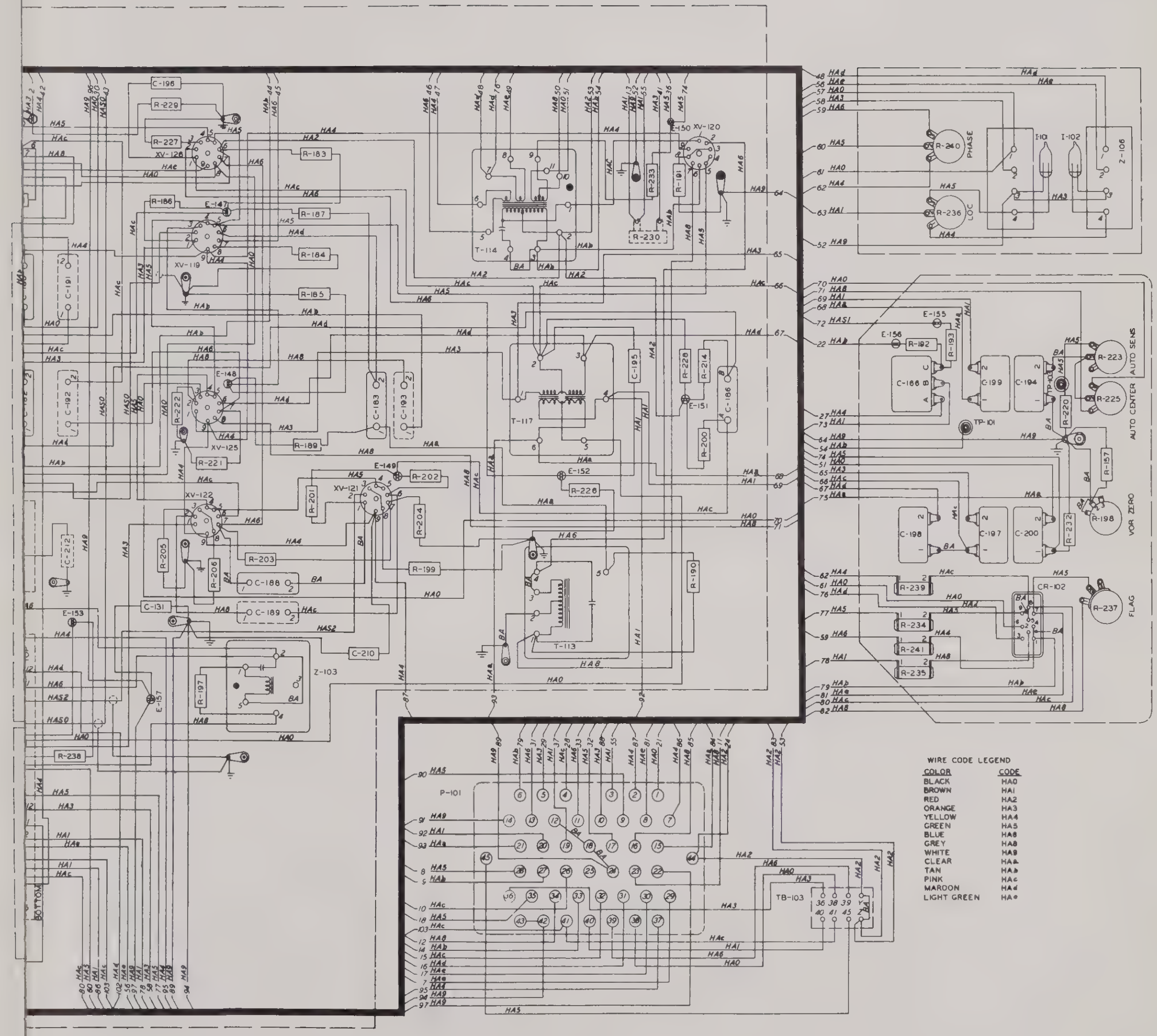


Figure 12-2C. 51R-3 Navigation Receiver Practical Wiring Diagram
(Serials 1696 and above) Wires have Tracer Color


XV-126
XV-119
XV-125
XV-122
XV-121
XV-120
T-114
T-117
T-113
Z-103
P-101
TB-103
R-240
PHASE
R-236
LOC
I-101
I-102
Z-106
R-223
AUTO SENS
R-225
AUTO CENTER
TP-101
R-198
VOR ZERO
CR-102
R-237
FLAG
BOTTOM

WIRE CODE LEGEND

COLOR	CODE
BLACK	HA0
BROWN	HA1
RED	HA2
ORANGE	HA3
YELLOW	HA4
GREEN	HA5
BLUE	HA6
GREY	HA8
WHITE	HA9
CLEAR	HAa
TAN	HAb
PINK	HAc
MAROON	HAd
LIGHT GREEN	HAe

Figure 12-2D. 51R-3 Navigation Receiver Practical Wiring Diagram (Serials 1696 and above) Wires have no Tracer lColor

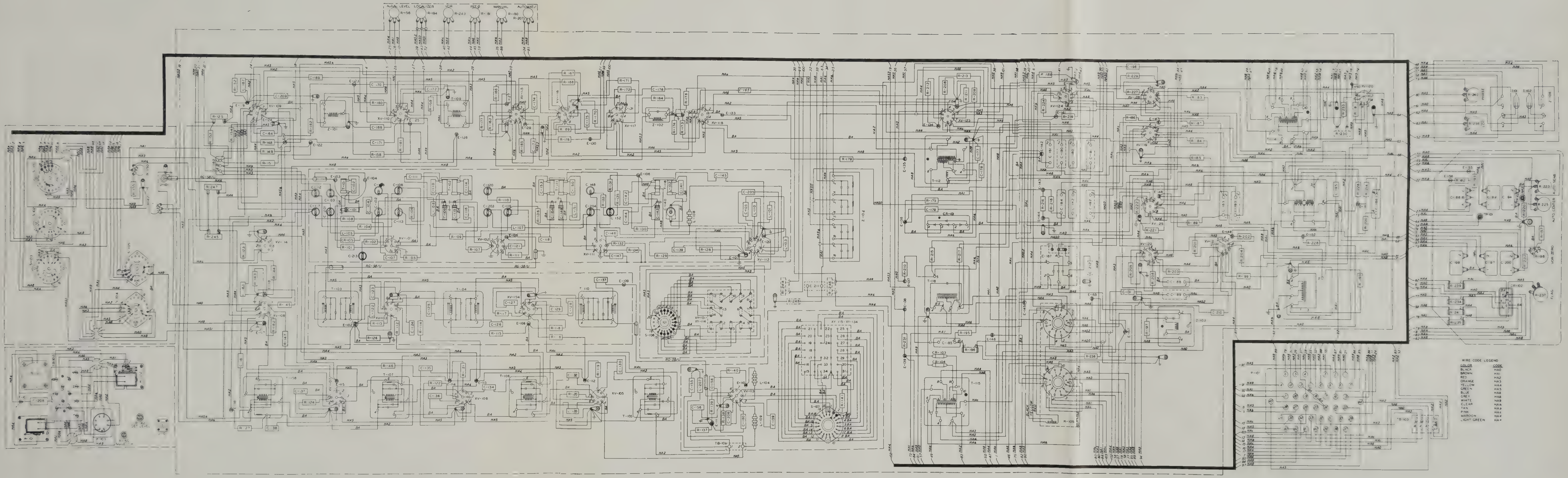
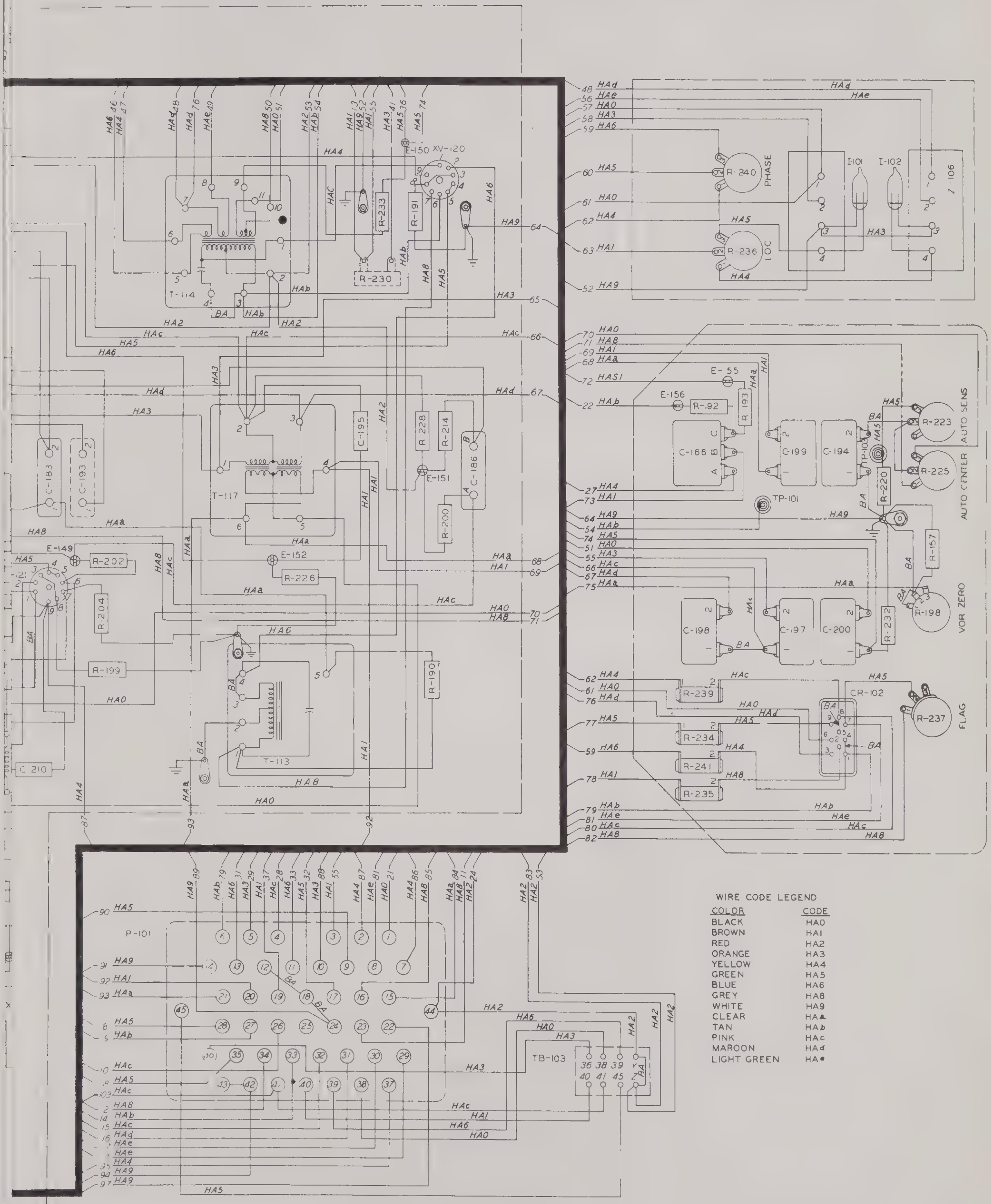

AUDIO LEVEL
LOCALIZER
ICR
RTC
MANUAL
AUTO
WIRE CODE LEGEND
COLOR
CODE
BLACK
HA0
BROWN
HA1
RED
HA2
ORANGE
HA3
YELLOW
HA4
GREEN
HA5
BLUE
HA6
GREY
HA8
WHITE
HA9
CLEAR
HAA
TAN
HAB
PINK
HAC
MAROON
HAD
LIGHT GREEN
HAE

Figure 12-2D. 51R-3 Navigation Receiver Practical Wiring Diagram
(Serials 1696 and above) Wires have no Tracer lColor


XV-120
E-150
R-233
R-191
R-230
T-114
T-117
C-195
R 228
R-214
C-186
E-151
R-200
C-183
C-193
E-149
R-202
R-204
E-152
R-226
R-199
R-190
T-113
C 210
P-101
TB-103
R-240
PHASE
R-236
IOC
I-101
I-102
I-106
E-55
E-156
R-.92
R 193
C-166
C-199
C-194
TP-102
R-223
AUTO SENS
R-225
AUTO CENTER
R-220
TP-101
R-157
R-198
VOR ZERO
C-198
C-197
C-200
R-232
R-239
R-234
R-241
R-235
CR-102
R-237
FLAG

WIRE CODE LEGEND

COLOR	CODE
BLACK	HA0
BROWN	HA1
RED	HA2
ORANGE	HA3
YELLOW	HA4
GREEN	HA5
BLUE	HA6
GREY	HA8
WHITE	HA9
CLEAR	HAa
TAN	HAb
PINK	HAc
MAROON	HAd
LIGHT GREEN	HAe

Figure 12-2E. 51R-3 Navigation Receiver Practical Wiring Diagram, Serial 2401 and above

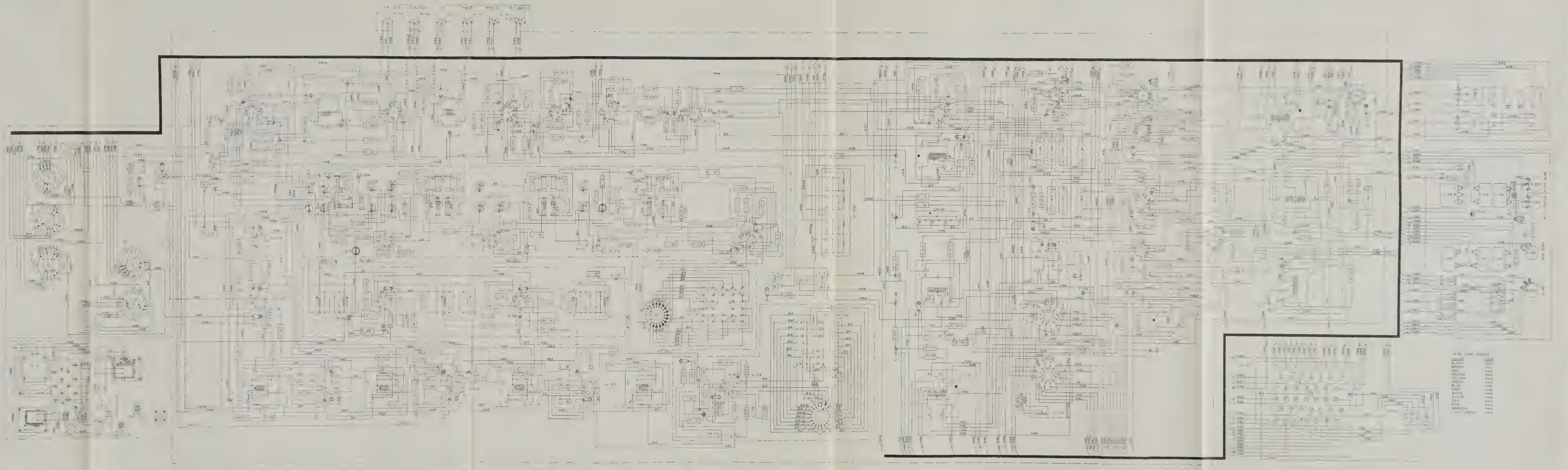

WIRE CODE LEGEND
COLOR CODE
BLACK HA0
BROWN HA1
RED HA2
ORANGE HA3
YELLOW HA4
GREEN HA5
BLUE HA6
GREY HA8
WHITE HA9
CLEAR HAa
TAN HAb
PINK HAc
MAROON HAd
LIGHT GREEN HAe

Figure 12-2E. 51R-3 Navigation Receiver Practical Wiring Diagram, Serial 2401 and above

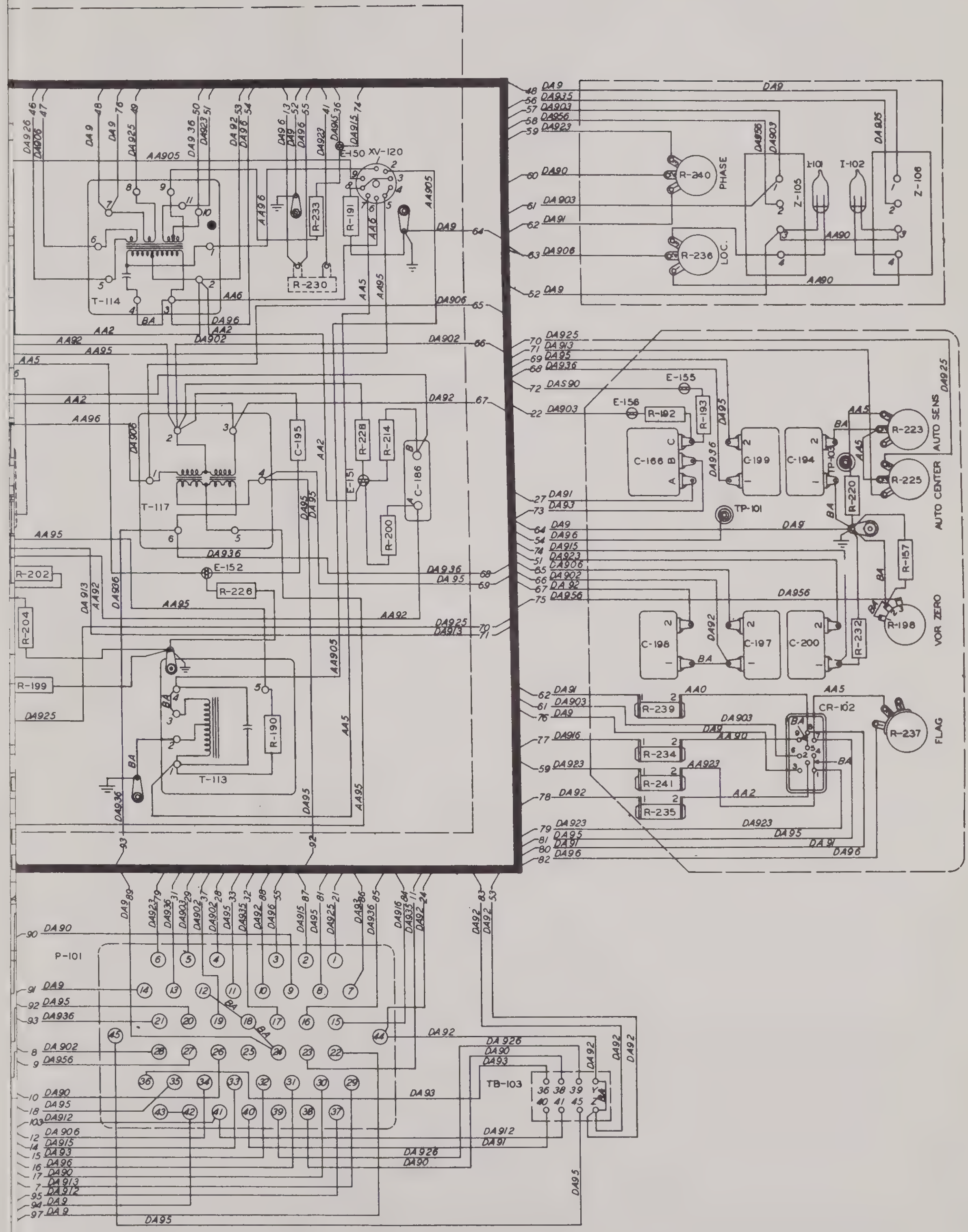

XV-120
E-150
T-114
R-230
R-233
R-191
T-117
C-195
R-228
R-214
C-186
E-151
R-200
E-152
R-226
R-202
R-204
R-199
T-113
R-190
R-240
PHASE
R-236
LOC.
Z-105
I-101
I-102
Z-106
E-155
E-156
R-192
R-193
C-166
C-199
C-194
TP-103
R-223
AUTO SENS
R-225
AUTO CENTER
R-220
TP-101
R-157
R-198
VOR ZERO
C-198
C-197
C-200
R-232
R-239
R-234
R-241
R-235
CR-102
R-237
FLAG
P-101
TB-103

Figure 12-2F. 51R-3 Navigation Receiver Practical Wiring Diagram, Serial 3821 and above

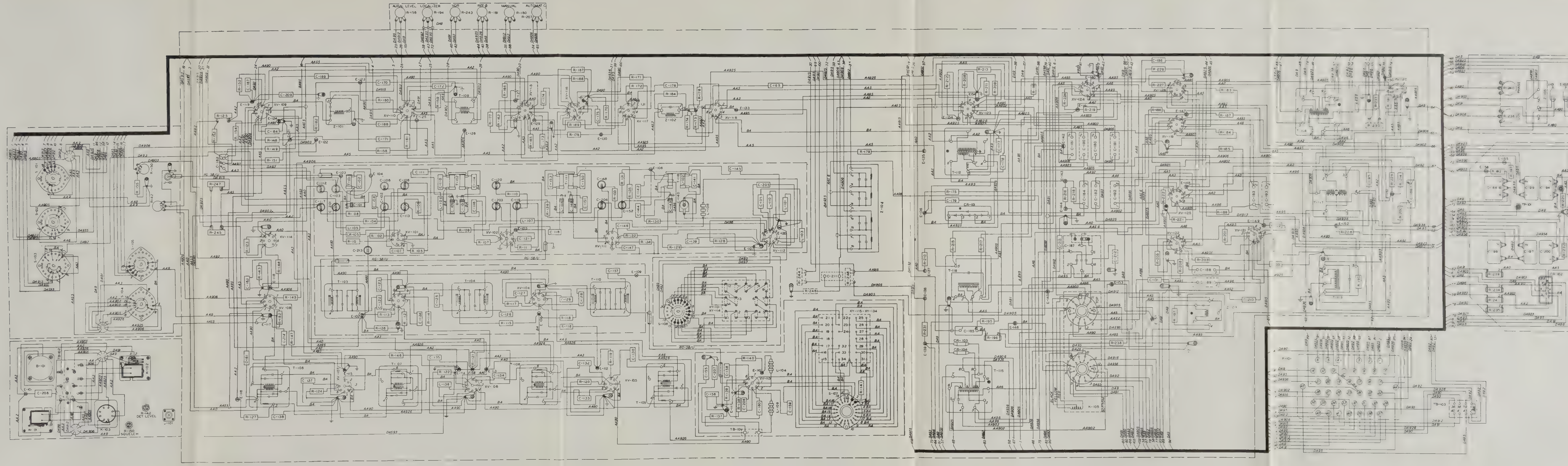
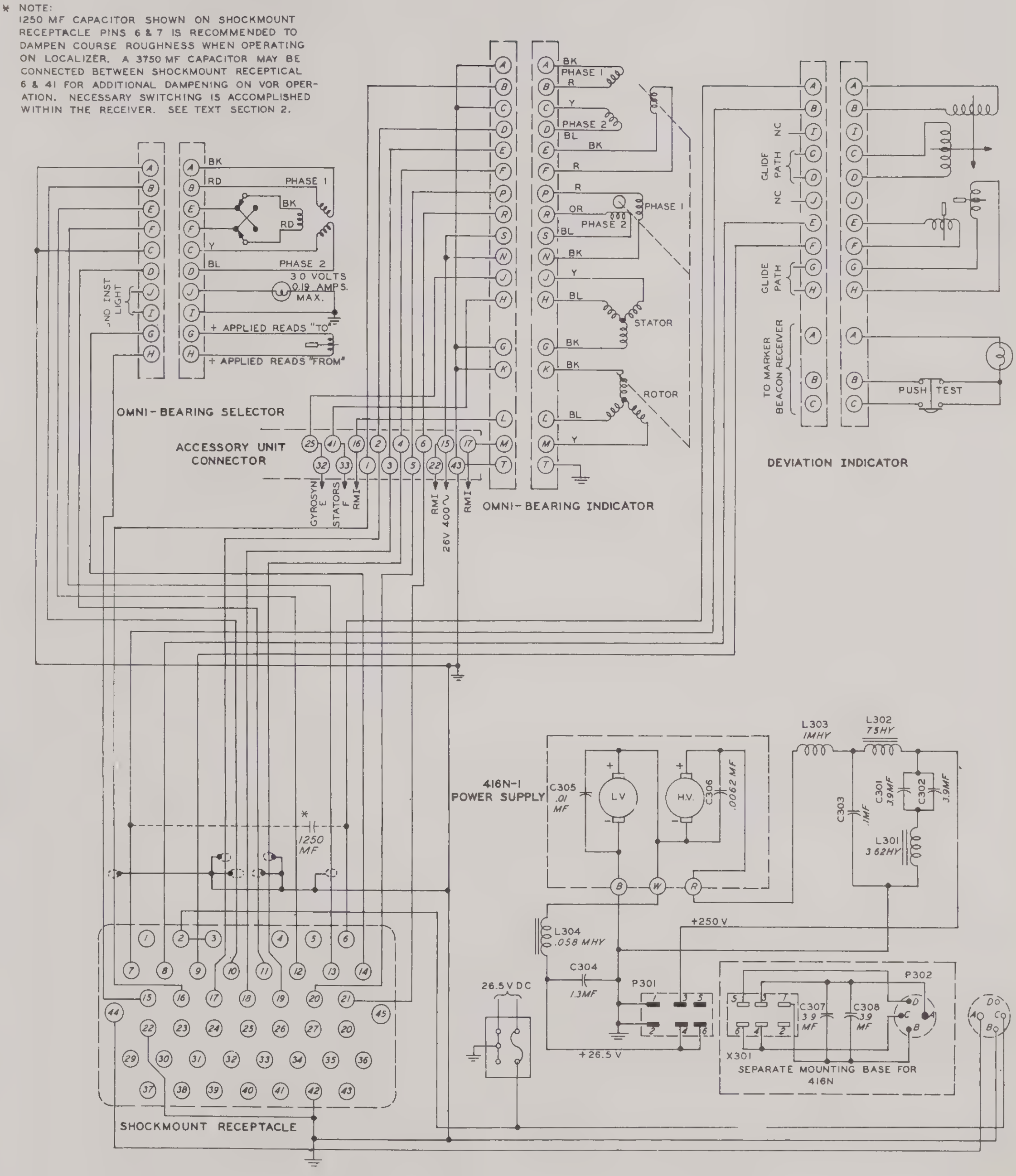

AURAL LEVEL
R-158
LOCALIZER
R-194
VOR
R-243
REF Ø
R-181
MANUAL
R-180
AUTOMATIC
R-207
R-162
DET LEVEL
R-160
SQUELCH

Figure 12-2F. 51R-3 Navigation Receiver Practical Wiring Diagram, Serial 3821 and above

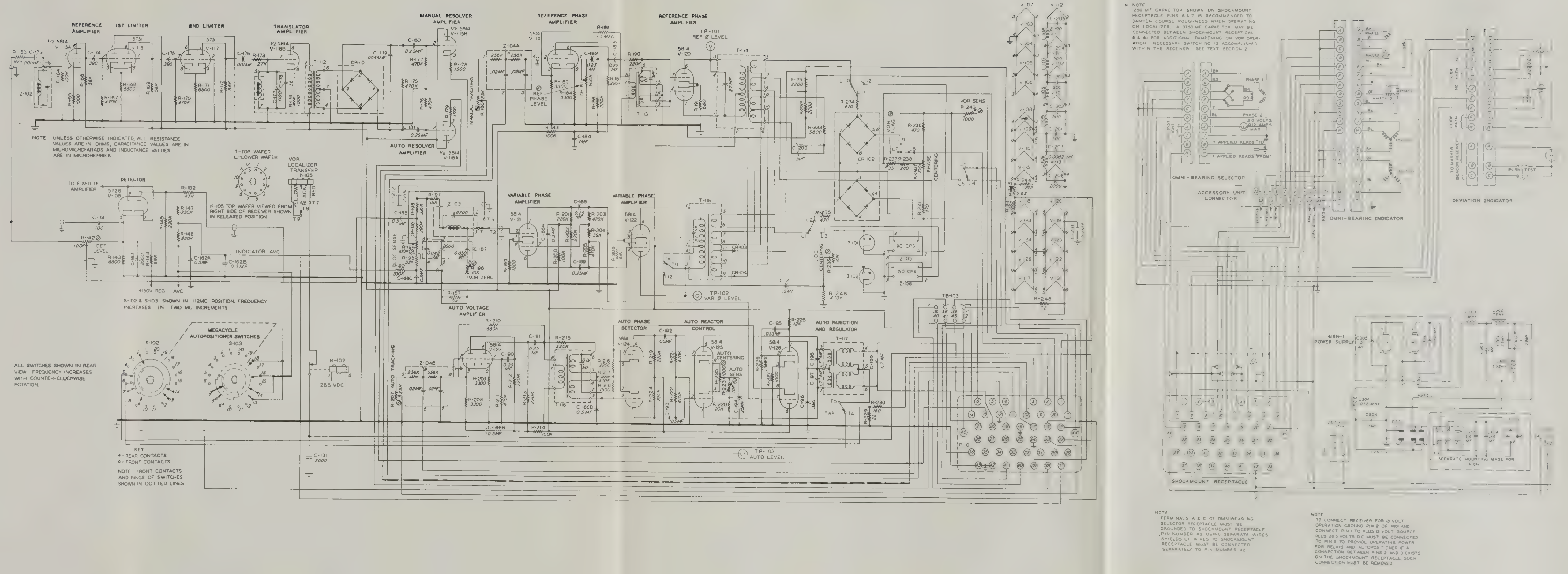

OMNI-BEARING SELECTOR
BK
RD
PHASE 1
BK
RD
Y
BL
PHASE 2
3.0 VOLTS
0.19 AMPS.
MAX.
+ APPLIED READS "TO"
+ APPLIED READS "FROM"
2ND INST LIGHT
ACCESSORY UNIT CONNECTOR
GYROSYN E
STATORS F
RMI
RMI
26V 400～
RMI
OMNI-BEARING INDICATOR
PHASE 1
PHASE 2
STATOR
ROTOR
OR
Y
DEVIATION INDICATOR
NC
GLIDE PATH
NC
GLIDE PATH
TO MARKER BEACON RECEIVER
PUSH TEST
416N-1 POWER SUPPLY
C305 .01 MF
L.V.
H.V.
C306 .0062 MF
L303 1MHY
L302 7.5HY
C303 .1MF
C301 3.9MF
C302 3.9MF
L301 3.62HY
L304 .058 MHY
+250 V
C304 1.3MF
P301
26.5 V DC
+26.5 V
P302
C307 3.9 MF
C308 3.9 MF
X301
SEPARATE MOUNTING BASE FOR 416N
1250 MF
SHOCKMOUNT RECEPTACLE

* NOTE:
1250 MF CAPACITOR SHOWN ON SHOCKMOUNT RECEPTACLE PINS 6 & 7 IS RECOMMENDED TO DAMPEN COURSE ROUGHNESS WHEN OPERATING ON LOCALIZER. A 3750 MF CAPACITOR MAY BE CONNECTED BETWEEN SHOCKMOUNT RECEPTICAL 6 & 41 FOR ADDITIONAL DAMPENING ON VOR OPERATION. NECESSARY SWITCHING IS ACCOMPLISHED WITHIN THE RECEIVER. SEE TEXT SECTION 2.

NOTE
TERMINALS A & C OF OMNIBEARING SELECTOR RECEPTACLE MUST BE GROUNDED TO SHOCKMOUNT RECEPTACLE PIN NUMBER 42 USING SEPARATE WIRES. SHIELDS OF WIRES TO SHOCKMOUNT RECEPTACLE MUST BE CONNECTED SEPARATELY TO PIN MUMBER 42.

NOTE:
TO CONNECT RECEIVER FOR 13 VOLT OPERATION GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE. PLUS 26.5 VOLTS D.C MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTOPOSITIONER IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED

. 51R-3 Navigation Receiver Instrumentation Section Schematic Diagram


REFERENCE AMPLIFIER
1ST LIMITER
2ND LIMITER
TRANSLATOR AMPLIFIER
MANUAL RESOLVER AMPLIFIER
REFERENCE PHASE AMPLIFIER
REFERENCE PHASE AMPLIFIER
AUTO RESOLVER AMPLIFIER
DETECTOR
TO FIXED IF AMPLIFIER
T-TOP WAFER
L-LOWER WAFER
VOR LOCALIZER TRANSFER K-105
YELLOW
BLACK
RED
INDICATOR AVC
+150V REG
AVC
VARIABLE PHASE AMPLIFIER
VARIABLE PHASE AMPLIFIER
AUTO VOLTAGE AMPLIFIER
VOR ZERO
TP-101 REF Ø LEVEL
TP-102 VAR Ø LEVEL
TP-103 AUTO LEVEL
VOR SENS
90 CPS
30 CPS
MEGACYCLE AUTOPOSITIONER SWITCHES
S-102
S-103
AUTO PHASE DETECTOR
AUTO REACTOR CONTROL
AUTO INJECTION AND REGULATOR
AUTO CENTERING
AUTO SENS
AUTO TRACKING
28.5 VDC
TB-103
OMNI-BEARING SELECTOR
ACCESSORY UNIT CONNECTOR
OMNI-BEARING INDICATOR
DEVIATION INDICATOR
PUSH TEST
PHASE 1
PHASE 2
3.0 VOLTS
+ APPLIED READS "TO"
+ APPLIED READS "FROM"
418N-1 POWER SUPPLY
SHOCKMOUNT RECEPTACLE
SEPARATE MOUNTING BASE FOR
P-101

NOTE UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES

K-105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION

S-102 & S-103 SHOWN IN 112MC POSITION. FREQUENCY INCREASES IN TWO MC INCREMENTS

ALL SWITCHES SHOWN IN REAR VIEW FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION.

KEY
● - REAR CONTACTS
○ - FRONT CONTACTS

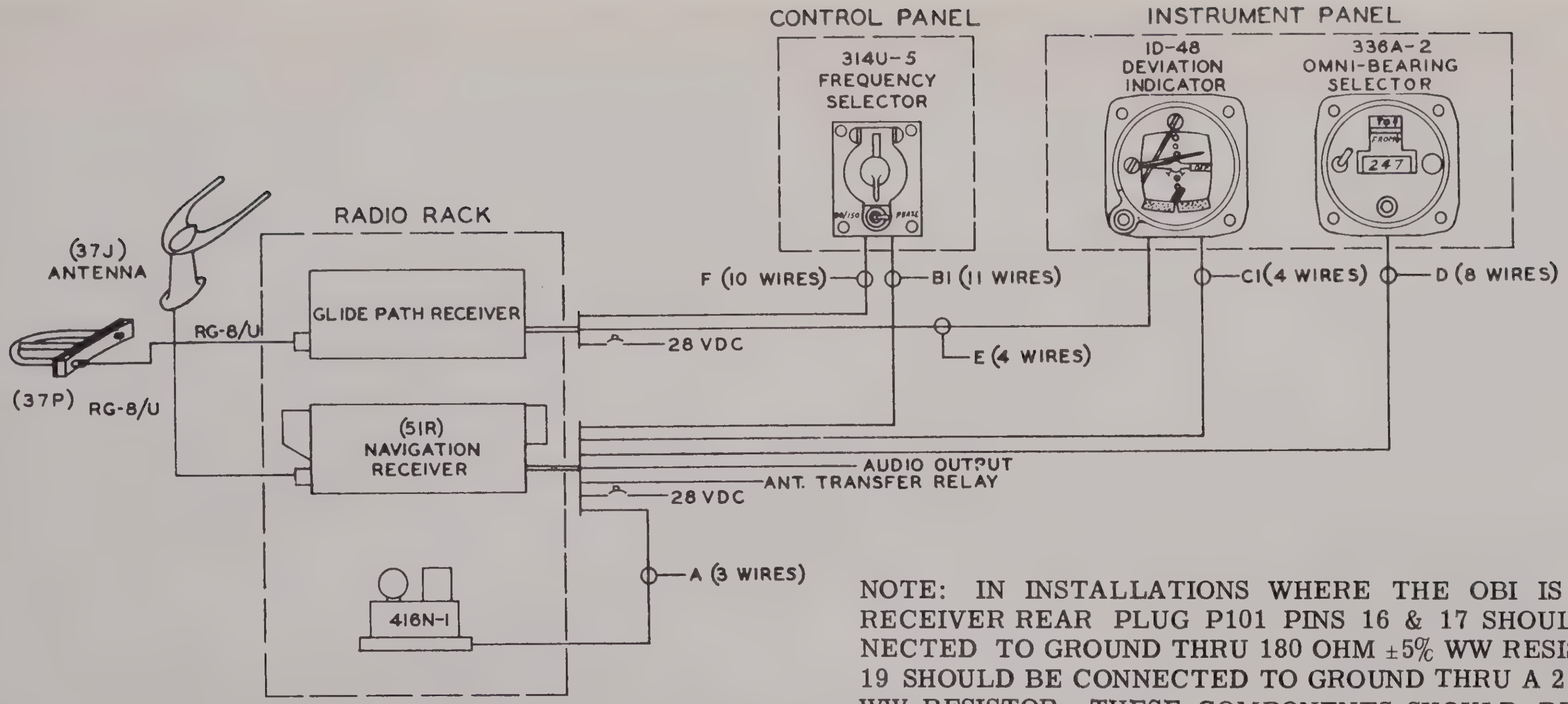
NOTE FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES

* NOTE
250 MF CAPACITOR SHOWN ON SHOCKMOUNT RECEPTACLE PINS 6 & 7 IS RECOMMENDED TO DAMPEN COURSE ROUGHNESS WHEN OPERATING ON LOCALIZER. A 3750 MF CAPACITOR MAY BE CONNECTED BETWEEN SHOCKMOUNT RECEPTICAL 6 & 41 FOR ADDITIONAL DAMPENING ON VOR OPERATION NECESSARY SWITCHING IS ACCOMPLISHED WITHIN THE RECEIVER SEE TEXT SECTION 2

NOTE
TERMINALS A & C OF OMNIBEARING SELECTOR RECEPTACLE MUST BE GROUNDED TO SHOCKMOUNT RECEPTACLE PIN NUMBER 42 USING SEPARATE WIRES SHIELDS OF WIRES TO SHOCKMOUNT RECEPTACLE MUST BE CONNECTED SEPARATELY TO PIN MUMBER 42

NOTE
TO CONNECT RECEIVER FOR 13 VOLT OPERATION GROUND PIN 2 OF P101 AND CONNECT PIN 1 TO PLUS 13 VOLT SOURCE PLUS 26.5 VOLTS D C MUST BE CONNECTED TO PIN 3 TO PROVIDE OPERATING POWER FOR RELAYS AND AUTOPOSITIONER IF A CONNECTION BETWEEN PINS 2 AND 3 EXISTS ON THE SHOCKMOUNT RECEPTACLE, SUCH CONNECTION MUST BE REMOVED

Figure 12-3. 51R-3 Navigation Receiver Instrumentation Section Schematic Diagram


CONTROL PANEL
314U-5 FREQUENCY SELECTOR
INSTRUMENT PANEL
ID-48 DEVIATION INDICATOR
336A-2 OMNI-BEARING SELECTOR
247
RADIO RACK
(37J) ANTENNA
(37P)
RG-8/U
RG-8/U
GLIDE PATH RECEIVER
(51R) NAVIGATION RECEIVER
416N-1
F (10 WIRES)
BI (11 WIRES)
CI (4 WIRES)
D (8 WIRES)
28 VDC
E (4 WIRES)
AUDIO OUTPUT
ANT. TRANSFER RELAY
28 VDC
A (3 WIRES)

NOTE: IN INSTALLATIONS WHERE THE OBI IS NOT USED RECEIVER REAR PLUG P101 PINS 16 & 17 SHOULD BE CONNECTED TO GROUND THRU 180 OHM ±5% WW RESISTORS. PIN 19 SHOULD BE CONNECTED TO GROUND THRU A 270 OHM ±5% WW RESISTOR. THESE COMPONENTS SHOULD BE MOUNTED ON THE SHOCKMOUNT.

CABLE KEY

A - POWER CABLE
  28 V DC
  250 DC B+
  GROUND

B - FREQUENCY CONTROL - NAV. REC.
  9 - WIRES FC.
  TONE-PHASE LOCALIZER
  GROUND

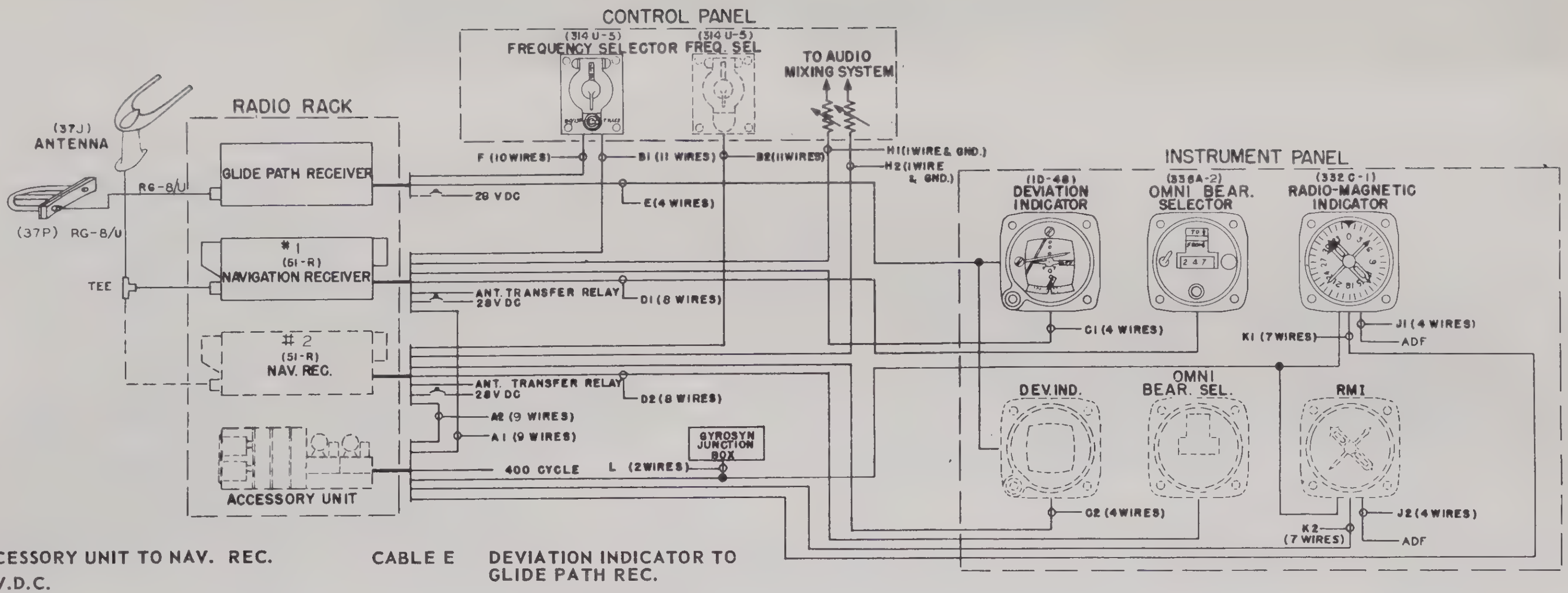
C - DEVIATION INDICATOR - NAV. REC.
  LOC - POINTER
  LOC - POINTER
  FLAG ALARM
  FLAG ALARM

D - OMNI BEARING SELECTOR
  AMBIGUITY METER
  AMBIGUITY METER
  RADIAL SEL STATOR
  RADIAL SEL STATOR
  RADIAL SEL STATOR
  RADIAL SEL STATOR
  RADIAL SEL ROTOR
  RADIAL SEL ROTOR

E - DEVIATION INDICATOR - GLIDE PATH REC.
  GLIDE PATH POINTER
  GLIDE PATH POINTER
  FLAG ALARM
  FLAG ALARM

F - FREQUENCY SELECTOR - GLIDE PATH REC.
  CHANNEL SELECTOR WIRES (10)

Figure 12-4. 51R-3 Installation Diagram, Minimum Instrumentation


CONTROL PANEL
(314 U-5)
FREQUENCY SELECTOR
(314 U-5)
FREQ. SEL
TO AUDIO MIXING SYSTEM
RADIO RACK
(37J) ANTENNA
(37P) RG-8/U
RG-8/U
TEE
GLIDE PATH RECEIVER
#1 (51-R) NAVIGATION RECEIVER
#2 (51-R) NAV. REC.
ACCESSORY UNIT
F (10 WIRES)
B1 (11 WIRES)
B2 (11 WIRES)
28 VDC
E (4 WIRES)
H1 (1 WIRE & GND.)
H2 (1 WIRE & GND.)
ANT. TRANSFER RELAY 28V DC
D1 (8 WIRES)
ANT. TRANSFER RELAY 28V DC
D2 (8 WIRES)
A2 (9 WIRES)
A1 (9 WIRES)
400 CYCLE
L (2 WIRES)
GYROSYN JUNCTION BOX
INSTRUMENT PANEL
(ID-48) DEVIATION INDICATOR
(336A-2) OMNI BEAR. SELECTOR
(332 C-1) RADIO-MAGNETIC INDICATOR
C1 (4 WIRES)
K1 (7 WIRES)
J1 (4 WIRES)
ADF
DEV. IND.
OMNI BEAR. SEL.
RMI
C2 (4 WIRES)
K2 (7 WIRES)
J2 (4 WIRES)
ADF

CABLE A ACCESSORY UNIT TO NAV. REC.
- 28 V.D.C.
- B+
- GROUND
- MOTOR PHASE
- MOTOR PHASE
- OMNI BEARING INDICATOR STATOR
- OMNI BEARING INDICATOR STATOR
- OMNI BEARING INDICATOR ROTOR
- OMNI BEARING INDICATOR ROTOR

CABLE B FREQUENCY SELECTOR TO NAV. REC.
- FREQUENCY CONTROL WIRES (10)
- TONE-PHASE LOC. SW.

CABLE C DEVIATION IND. TO NAV. REC.
- LOC. POINTER
- LOC. POINTER
- FLAG ALARM
- FLAG ALARM

CABLE D OMNI BEAR. SELECTOR. TO NAV. REC.
- AMBIGUITY METER
- AMBIGUITY METER
- OMNI BEARING SEL. STATOR
- OMNI BEARING SEL. STATOR
- OMNI BEARING SEL. STATOR
- OMNI BEARING SEL. STATOR
- OMNI BEARING SEL. ROTOR
- OMNI BEARING SEL. ROTOR

CABLE E DEVIATION INDICATOR TO GLIDE PATH REC.
- GLIDE PATH POINTER
- GLIDE PATH POINTER
- GLIDE PATH FLAG ALARM
- GLIDE PATH FLAG ALARM

CABLE F FREQUENCY SELECTOR TO GLIDE PATH REC.
- CHANNEL SELECTOR WIRES (10)

CABLE H NAV. REC. TO AUDIO MIXING SYSTEM
- AUDIO LINE *

CABLE J RMI TO ADF
- ADF AUTOSYN STATOR
- ADF AUTOSYN STATOR
- ADF AUTOSYN STATOR & ROTOR COMMON
- ADF AUTOSYN ROTOR

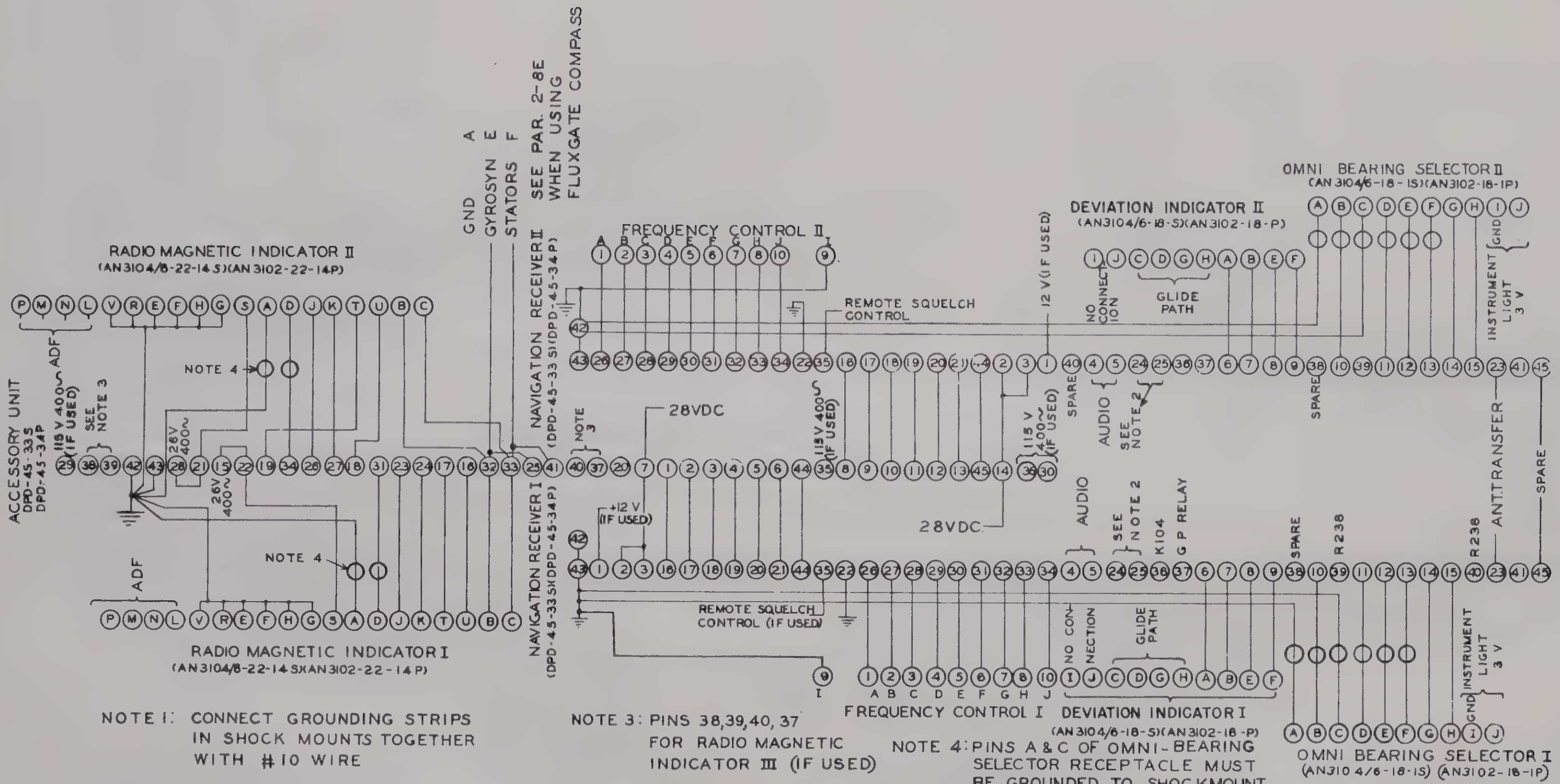
CABLE K ACCESSORY UNIT TO RMI
- VHF ADF AUTOSYN STATOR
- VHF ADF AUTOSYN STATOR
- 26 V 400 CYCLE - ROTOR
- GROUND
- MOTOR PHASE
- MOTOR PHASE
- MAGNETIC FOLLOW UP SIGNAL

CABLE L ACCESSORY UNIT TO RMI
- GYROSYN STATOR
- GYROSYN STATOR

NOTES:

1. NO PROVISIONS SHOWN FOR RMI OR DEVIATION IND. SWITCHING
2. NO PROVISIONS SHOWN FOR ON-OFF SWITCHING.
3. AUTOMATIC RADIO FLIGHT CONTROL (FOR LANDING OR ENROUTE FLYING) CONNECTS TO RECEIVER OUTPUT CIRCUITS IN PARALLEL WITH DEVIATION INDICATORS.
4. ACCESSORY UNIT TO CONTAIN:
   - OMNI BEARING INDICATORS
   - DYNAMOTORS
   - SPACE AVAILABLE FOR 3 RMI DIAL DRIVE SERVO AMPLIFIERS IF REQUIRED
5. 400 CYCLE MUST BE FROM SAME SOURCE AS GYROSYN COMPASS
6. WIRES MARKED WITH * TENTATIVELY SHIELDED
7. NO WIRING SHOWN FOR INSTRUMENT LIGHTING
8. ANTENNA TRANSFER WIRE OPEN CIRCUIT BELOW 122 MC. ENERGIZED (26V) 122 MC. AND ABOVE

Figure 12-5. 51R-3 Installation Diagram, Maximum Instrumentation


RADIO MAGNETIC INDICATOR II
(AN3104/6-22-14S)(AN3102-22-14P)
ACCESSORY UNIT
DPD-45-33S
DPD-45-34P
ADF
115 V 400~
(IF USED)
SEE NOTE 3
NOTE 4
26V 400~
GND A
GYROSYN E
STATORS F
SEE PAR. 2-8E
WHEN USING
FLUXGATE COMPASS
NAVIGATION RECEIVER II
(DPD-45-33 S)(DPD-45-34P)
NAVIGATION RECEIVER I
(DPD-45-33S)(DPD-45-34P)
NOTE 3
28VDC
+12 V
(IF USED)
FREQUENCY CONTROL II
A B C D E F G H J I
REMOTE SQUELCH
CONTROL
REMOTE SQUELCH
CONTROL (IF USED)
115 V 400~
(IF USED)
12 V(IF USED)
115 V
400~
(IF USED)
SPARE
AUDIO
SEE NOTE 2
K104
G P RELAY
R238
ANT.TRANSFER
SPARE
DEVIATION INDICATOR II
(AN3104/6-18-S)(AN3102-18-P)
NO CONNECTION
GLIDE PATH
OMNI BEARING SELECTOR II
(AN3104/6-18-1S)(AN3102-18-1P)
INSTRUMENT LIGHT 3 V
GND
ADF
RADIO MAGNETIC INDICATOR I
(AN3104/6-22-14S)(AN3102-22-14P)
FREQUENCY CONTROL I
DEVIATION INDICATOR I
(AN3104/6-18-S)(AN3102-18-P)
NO CONNECTION
OMNI BEARING SELECTOR I
(AN3104/6-18-1S) (AN3102-18-1P)

NOTE 1: CONNECT GROUNDING STRIPS IN SHOCK MOUNTS TOGETHER WITH #10 WIRE

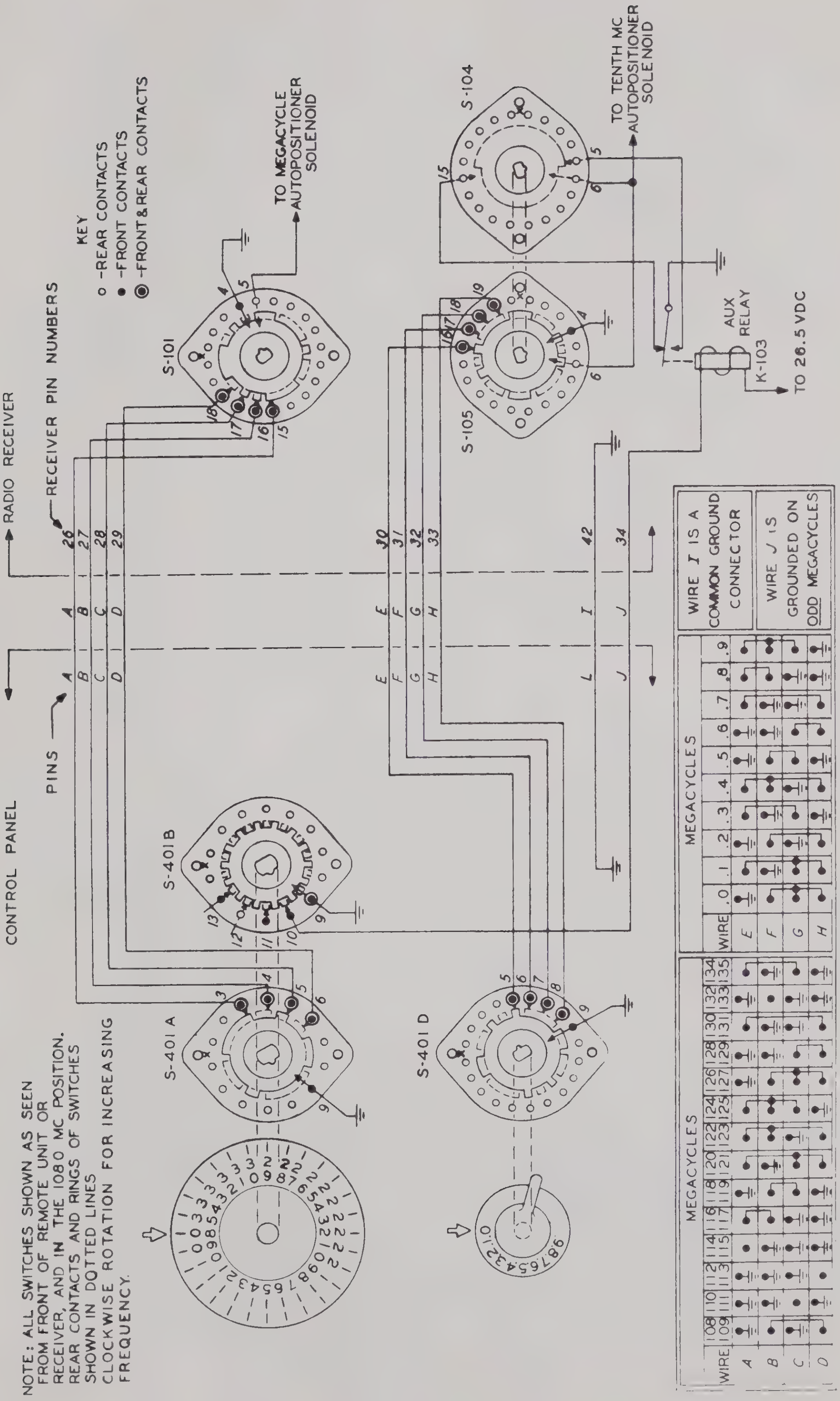
NOTE 2: PINS 24 & 25 ARE FOR 26V 400∿ THESE PINS NEED NOT BE WIRED WHEN USING COLLINS 51R RECEIVER PIN 24 GND IF 400∿ IS GROUNDED

NOTE 3: PINS 38,39,40, 37 FOR RADIO MAGNETIC INDICATOR III (IF USED)

NOTE 4: PINS A & C OF OMNI-BEARING SELECTOR RECEPTACLE MUST BE GROUNDED TO SHOCKMOUNT RECEPTACLE PIN 42 USING SEPARATE WIRES. SHIELDS OF WIRES MUST CONNECT SEPARATELY TO PIN 42.

NOTE 5: PIN 41 METER DAMPING SWITCH SEE PAR. 2-8C. PIN 37, +28 V. FOR GLIDE SLOPE RELAY

Figure 12-6. 51R-3 System Interconnections Diagram



NOTE: ALL SWITCHES SHOWN AS SEEN FROM FRONT OF REMOTE UNIT OR RECEIVER, AND IN THE 1080 MC POSITION. REAR CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES CLOCKWISE ROTATION FOR INCREASING FREQUENCY.

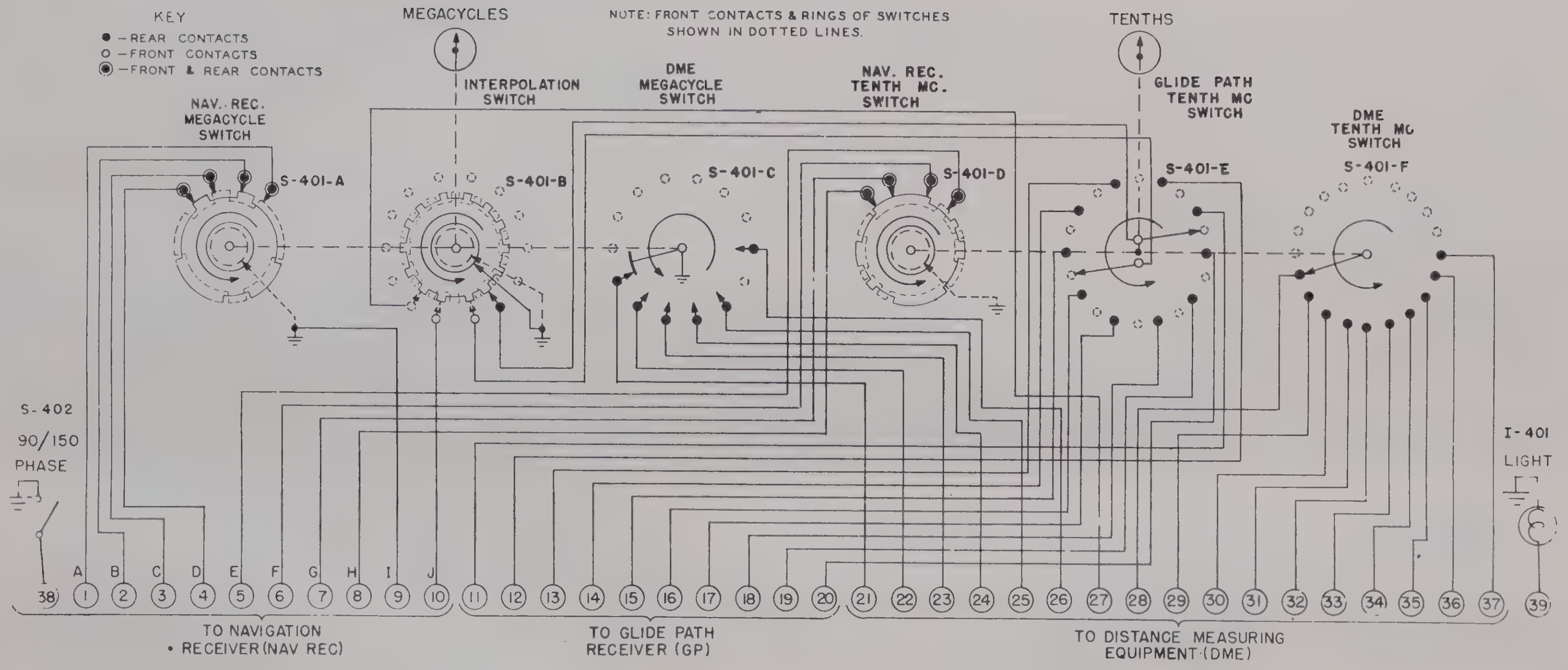
KEY
○ -REAR CONTACTS
● -FRONT CONTACTS
◉ -FRONT & REAR CONTACTS

WIRE *I* IS A COMMON GROUND CONNECTOR

WIRE *J* IS GROUNDED ON ODD MEGACYCLES

CONTROL PANEL
PINS
RADIO RECEIVER
RECEIVER PIN NUMBERS
S-401 A
S-401 B
S-401 D
S-101
S-105
S-104
TO MEGACYCLE AUTOPOSITIONER SOLENOID
TO TENTH MC AUTOPOSITIONER SOLENOID
AUX RELAY
K-103
TO 26.5 VDC
A B C D E F G H L J I J
26 27 28 29 30 31 32 33 42 34
MEGACYCLES
WIRE A B C D
108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135
WIRE E F G H
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9

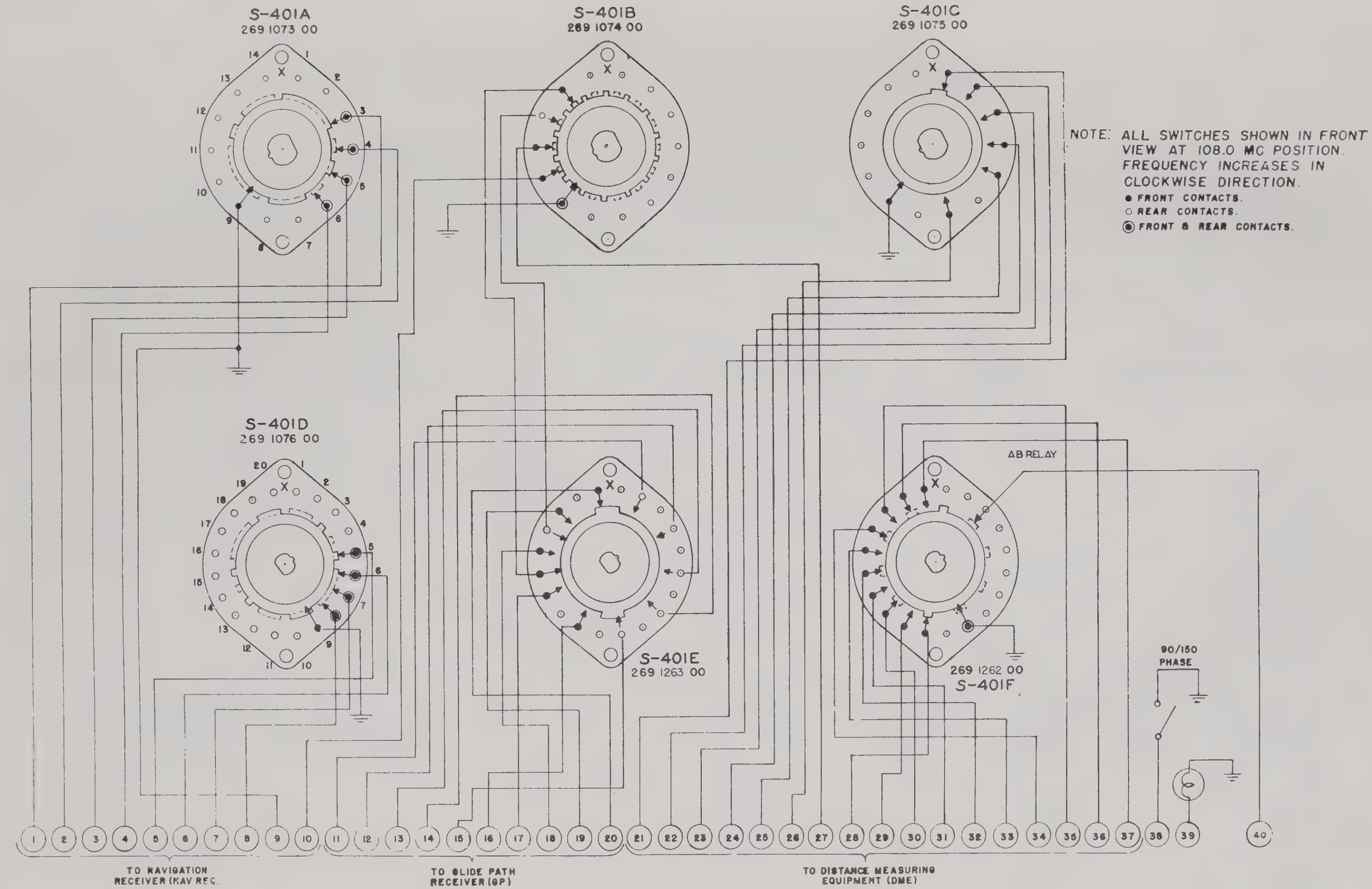
Figure 12-7. Remote Control System Schematic


KEY
● —REAR CONTACTS
○ —FRONT CONTACTS
◉ —FRONT & REAR CONTACTS
MEGACYCLES
NOTE: FRONT CONTACTS & RINGS OF SWITCHES SHOWN IN DOTTED LINES.
TENTHS
NAV. REC. MEGACYCLE SWITCH
S-401-A
INTERPOLATION SWITCH
S-401-B
DME MEGACYCLE SWITCH
S-401-C
NAV. REC. TENTH MC. SWITCH
S-401-D
GLIDE PATH TENTH MC SWITCH
S-401-E
DME TENTH MC SWITCH
S-401-F
S-402
90/150
PHASE
I-401
LIGHT
A
B
C
D
E
F
G
H
I
J
38
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
39
TO NAVIGATION • RECEIVER (NAV REC)
TO GLIDE PATH RECEIVER (GP)
TO DISTANCE MEASURING EQUIPMENT (DME)

NOTE: ALL SWITCHES SHOWN IN REAR VIEW AT 108.0 MC. POSITION. FREQUENCY INCREASES IN COUNTER-CLOCKWISE DIRECTION.

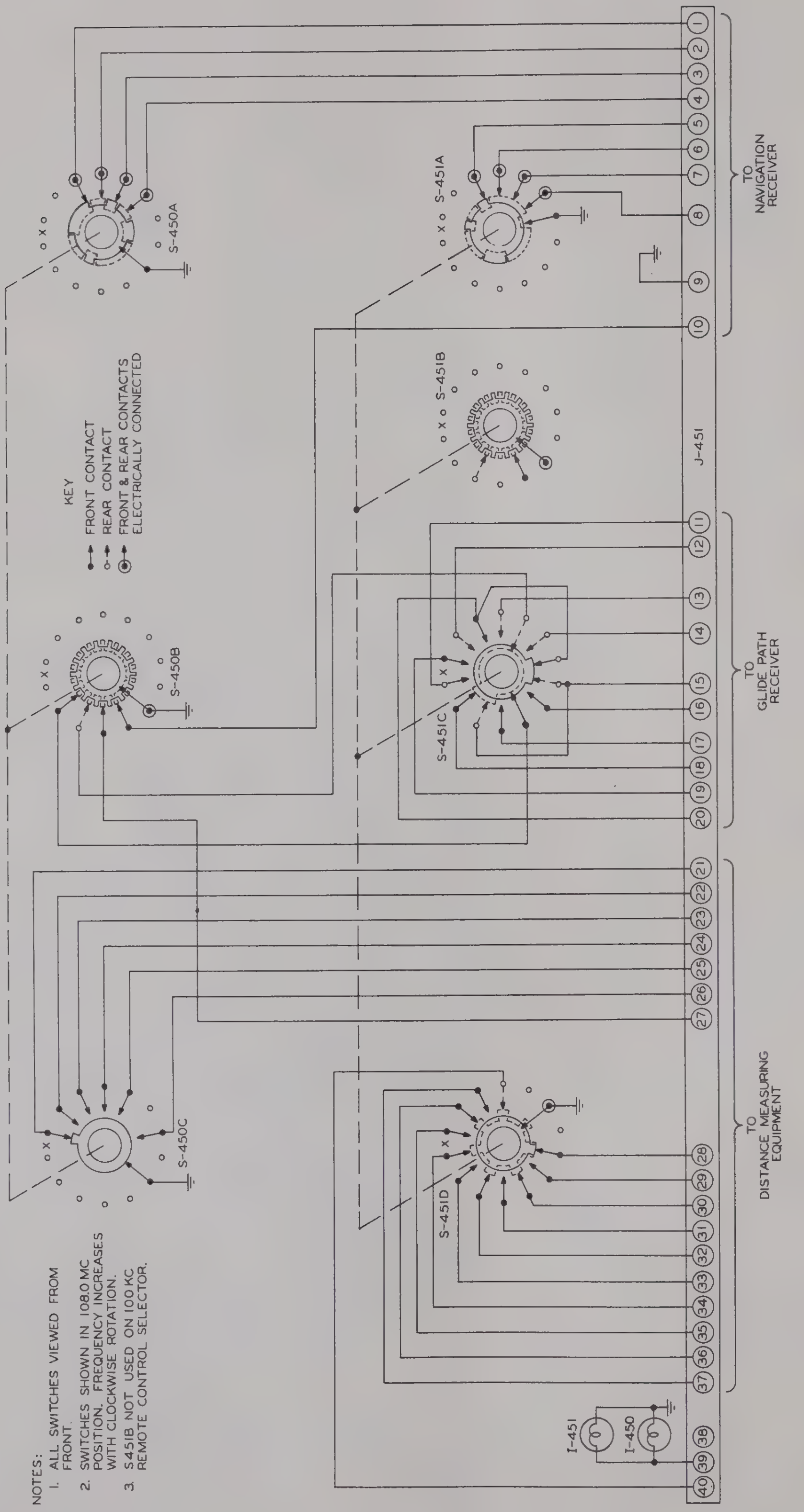
DME SWITCH WIRES NOT INSTALLED IN UNITS AS SHIPPED

Figure 12-8. Type 314U-1 Frequency Control Unit, Schematic


S-401A
269 1073 00
S-401B
269 1074 00
S-401C
269 1075 00
S-401D
269 1076 00
S-401E
269 1263 00
S-401F
269 1262 00
ΔB RELAY
90/150
PHASE
TO NAVIGATION
RECEIVER (NAV REC.
TO GLIDE PATH
RECEIVER (GP)
TO DISTANCE MEASURING
EQUIPMENT (DME)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

NOTE: ALL SWITCHES SHOWN IN FRONT VIEW AT 108.0 MC POSITION. FREQUENCY INCREASES IN CLOCKWISE DIRECTION.
- ● FRONT CONTACTS.
- ○ REAR CONTACTS.
- ◉ FRONT & REAR CONTACTS.

Figure 12-9. Type 314U-5 Frequency Control Unit, Schematic


KEY
FRONT CONTACT
REAR CONTACT
FRONT & REAR CONTACTS ELECTRICALLY CONNECTED
S-450A
S-450B
S-450C
S-451A
S-451B
S-451C
S-451D
J-451
I-451
I-450
TO NAVIGATION RECEIVER
TO GLIDE PATH RECEIVER
TO DISTANCE MEASURING EQUIPMENT
o x o
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

NOTES:
1. ALL SWITCHES VIEWED FROM FRONT.
2. SWITCHES SHOWN IN 108.0 MC POSITION. FREQUENCY INCREASES WITH CLOCKWISE ROTATION.
3. S451B NOT USED ON 100 KC REMOTE CONTROL SELECTOR.

Figure 12-10. Type 314U-8 Frequency Control Unit, Schematic

MEGACYCLES

WIRE	108 109	110 111	112 113	114 115	116 117	118 119	120 121	122 123	124 125	126 127	128 129	130 131	132 133	134 135
1	X	X	X		●	X	●	●	●	X	X	●	X	●
2	●	X	X	X	●	●	X	●	●	●	X	X		X
3	X		X	X	X	●	●	X	●	●	●	X	X	●
4	●	X		X	X	X	●	●	X	●	●	●	X	X

MEGACYCLES

WIRE	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
5	X	●	X	●	●	X	X	●	●	●
6	●	X	●	X	●	●	X	X	●	●
7	●	●	X	●	X	●	●	X	X	●
8	●	●	●	X	●	X	●	●	X	X

X INDICATES GROUND
WIRE 9 IS COMMON GROUND
WIRE 10 IS GROUNDED ON ODD MEGACYCLES

NOTE: ALL SWITCHES SHOWN IN FRONT VIEW AT 108.0 MC. POSITION. FREQUENCY INCREASES IN CLOCKWISE DIRECTION.

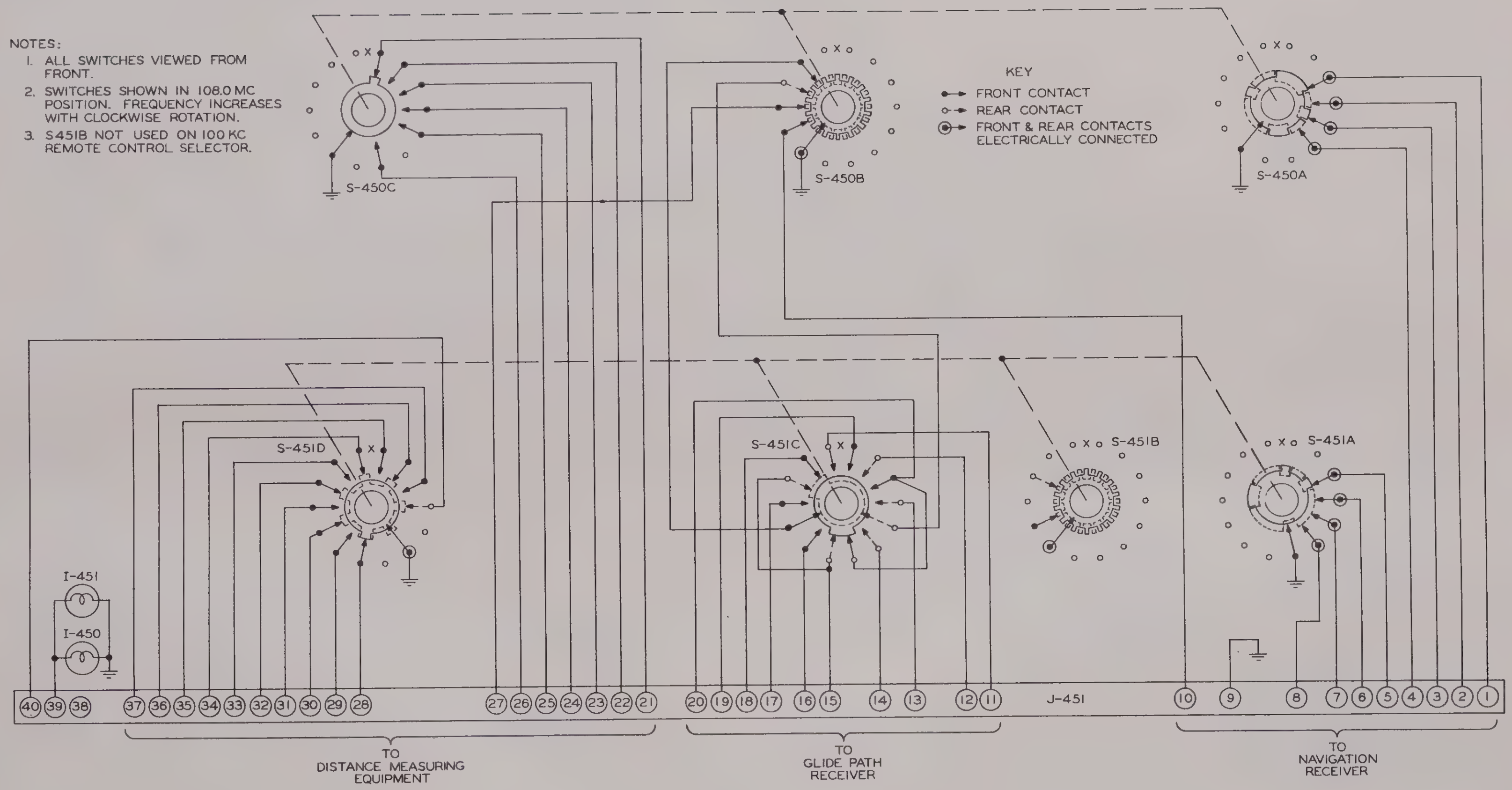
KEY

●→ FRONT CONTACTS

○→ REAR CONTACTS

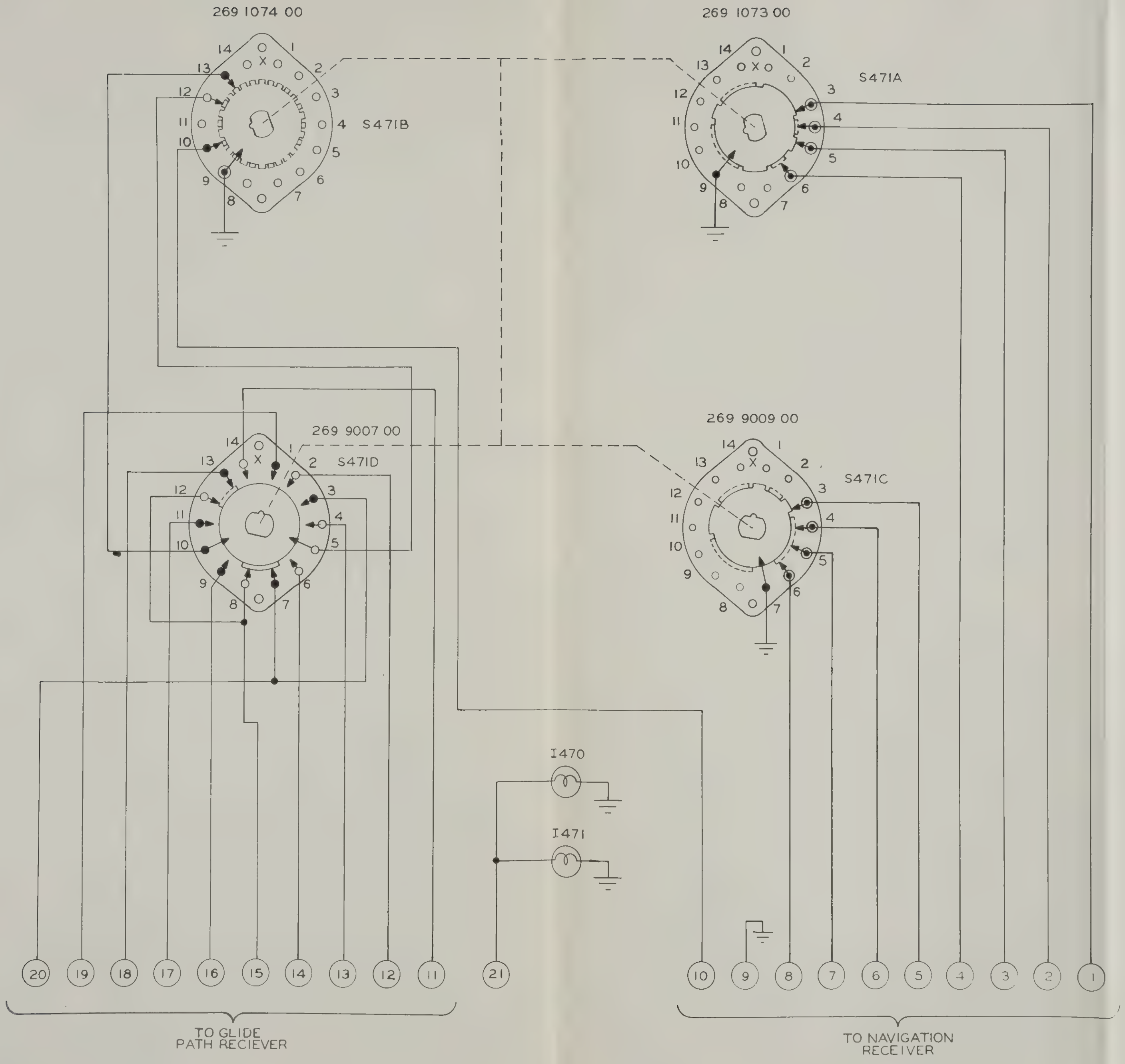
◉→ FRONT AND REAR CONTACTS

J-10 Frequency Control Unit,
Schematic

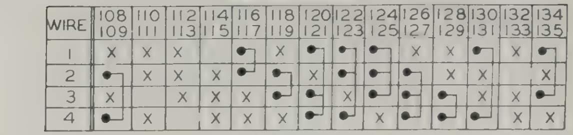

S-450C
S-450B
S-450A
KEY
FRONT CONTACT
REAR CONTACT
FRONT & REAR CONTACTS ELECTRICALLY CONNECTED
S-451D
S-451C
S-451B
S-451A
I-451
I-450
J-451
40 39 38 37 36 35 34 33 32 31 30 29 28
27 26 25 24 23 22 21
20 19 18 17 16 15 14 13 12 11
10 9 8 7 6 5 4 3 2 1
TO DISTANCE MEASURING EQUIPMENT
TO GLIDE PATH RECEIVER
TO NAVIGATION RECEIVER

NOTES:
1. ALL SWITCHES VIEWED FROM FRONT.
2. SWITCHES SHOWN IN 108.0 MC POSITION. FREQUENCY INCREASES WITH CLOCKWISE ROTATION.
3. S451B NOT USED ON 100 KC REMOTE CONTROL SELECTOR.

Figure 12-10. Type 314U-8 Frequency Control Unit, Schematic

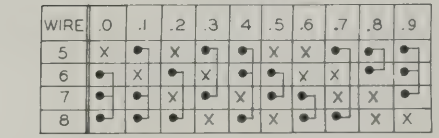

269 1074 00
S471B
269 1073 00
S471A
269 9007 00
S471D
269 9009 00
S471C
I470
I471
20
19
18
17
16
15
14
13
12
11
21
10
9
8
7
6
5
4
3
2
1
TO GLIDE PATH RECIEVER
TO NAVIGATION RECEIVER

MEGACYCLES



WIRE	108 109	110 111	112 113	114 115	116 117	118 119	120 121	122 123	124 125	126 127	128 129	130 131	132 133	134 135
1	X	X	X		●	X	●	●	●	X	X	●	X	●
2	●	X	X	X	●	●	X	●	●	●	X	X		X
3	X		X	X	X	●	●	X	●	●	●	X	X	●
4	●	X		X	X	X	●	●	X	●	●	●	X	X

MEGACYCLES



WIRE	.0	.1	.2	.3	4	.5	.6	.7	.8	.9
5	X	●	X	●	●	X	X	●	●	●
6	●	X	●	X	●	●	X	X	●	●
7	●	●	X	●	X	●	●	X	X	●
8	●	●	●	X	●	X	●	●	X	X

X INDICATES GROUND
WIRE 9 IS COMMON GROUND
WIRE 10 IS GROUNDED ON ODD MEGACYCLES

NOTE: ALL SWITCHES SHOWN IN FRONT VIEW AT 108.0 MC. POSITION. FREQUENCY INCREASES IN CLOCKWISE DIRECTION.

KEY

●→ FRONT CONTACTS
○→ REAR CONTACTS
◉→ FRONT AND REAR CONTACTS

Figure 12-11. 314U-10 Frequency Control Unit, Schematic

	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
1	X	X	X	X	X	X					X	X							X	X	X	X			X	X		
2			X	X	X	X	X	X					X	X							X	X	X	X			X	X
3	X	X			X	X	X	X	X	X					X	X							X	X	X	X		
4			X	X			X	X	X	X	X	X					X	X							X	X	X	X
10		X		X		X		X		X		X		X		X		X		X		X		X		X		X

	00	10	20	30	40	50	60	70	80	90
5	X		X			X	X			
6		X		X			X	X		
7			X		X			X	X	
8				X		X			X	X

NOTE:
"X" INDICATES GROUND.
WIRE 9 IS GROUNDED.

NOT USED WITH TRANSMITTER

	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
12	X	X	X	X	X	X					X	X							X	X	X	X			X	X		
13			X	X	X	X	X	X					X	X							X	X	X	X			X	X
14	X	X			X	X	X	X	X	X					X	X							X	X	X	X		
15			X	X			X	X	X	X	X	X					X	X							X	X	X	X
20		X		X		X		X		X		X		X		X		X		X		X		X		X		X
21	X		X		X		X		X		X		X		X		X		X		X		X		X		X	

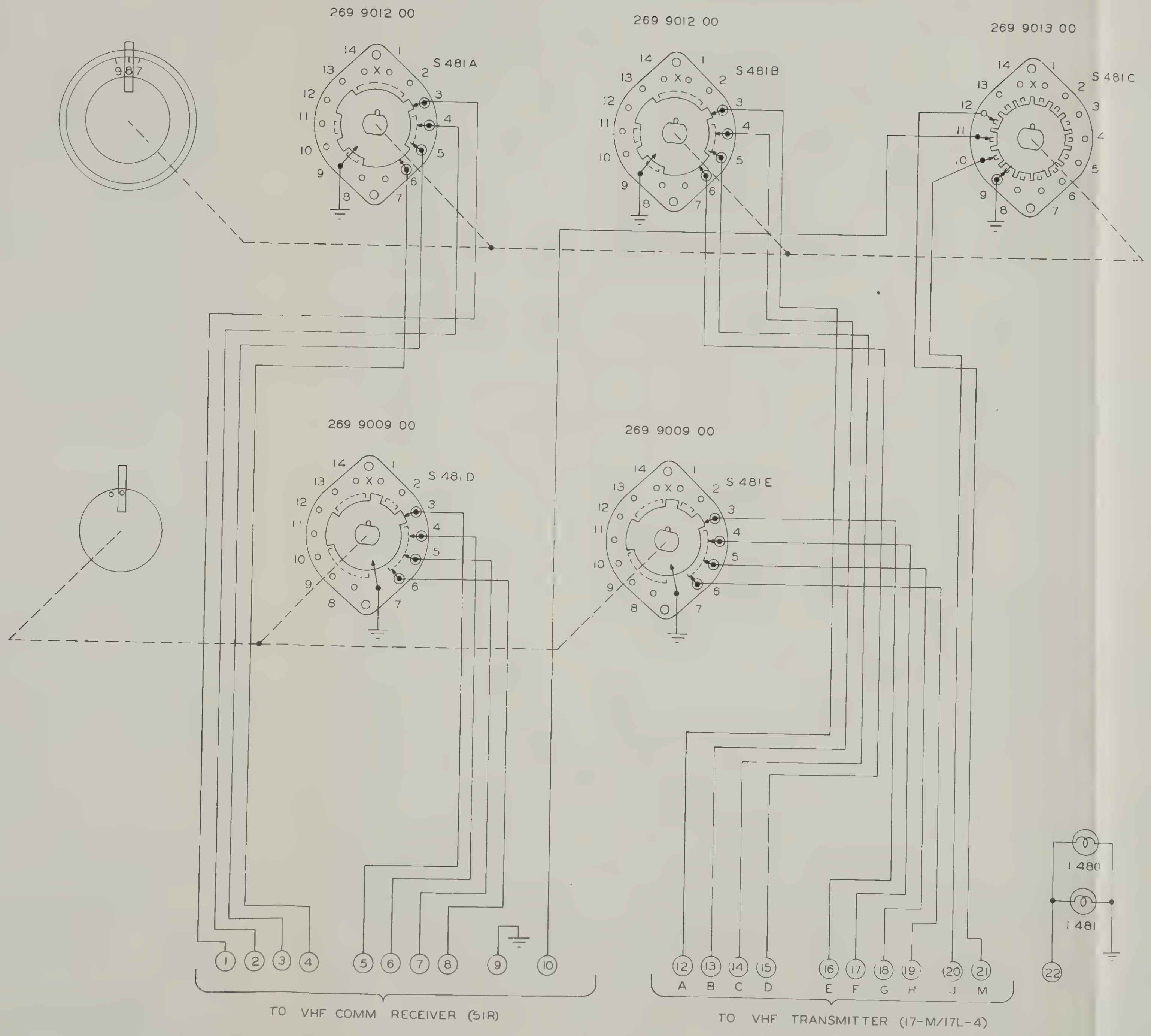
	00	10	20	30	40	50	60	70	80	90
16	X		X			X	X			
17		X		X			X	X		
18			X		X			X	X	
19				X		X			X	X

NOTE:

1. ALL SWITCHES SHOWN IN FRONT VIEW AT 118.0 MC POSITION. FREQUENCY INCREASES IN CLOCKWISE DIRECTION.
2. FRONT AND REAR ROTOR BLADES ARE INSULATED FROM EACH OTHER

KEY:
●→ FRONT CONTACTS
○→ REAR CONTACTS
◉→ FRONT AND REAR CONTACTS

Figure 12-12. 614F-2 Frequency Control Unit. Schematic


987
269 9012 00
S481A
269 9012 00
S481B
269 9013 00
S481C
269 9009 00
S481D
269 9009 00
S481E
1
2
3
4
5
6
7
8
9
10
11
12
13
14
X
I480
I481
22
TO VHF COMM RECEIVER (51R)
12 A
13 B
14 C
15 D
16 E
17 F
18 G
19 H
20 J
21 M
TO VHF TRANSMITTER (17-M/17L-4)

	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
1	X	X	X	X	X	X					X	X							X	X	X	X			X	X		
2			X	X	X	X	X	X					X	X							X	X	X	X			X	X
3	X	X			X	X	X	X	X	X					X	X							X	X	X	X		
4			X	X			X	X	X	X	X	X					X	X							X	X	X	X
10		X		X		X		X		X		X		X		X		X		X		X		X		X		X

	000	100	200	300	400	500	600	700	800	900
5	X		X			X	X			
6		X		X			X	X		
7			X		X			X	X	
8				X		X			X	X

NOTE:
"X" INDICATES GROUND.
WIRE 9 IS GROUNDED.

NOT USED WITH TRANSMITTER (108–117)

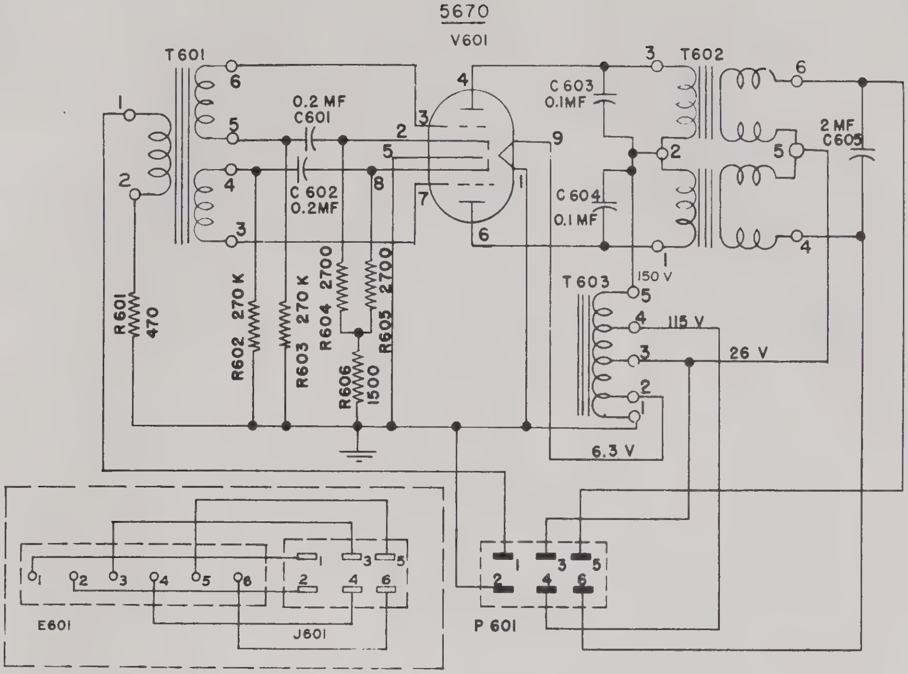
	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
12	X	X	X	X	X	X					X	X							X	X	X	X			X	X		
13			X	X	X	X	X	X					X	X							X	X	X	X			X	X
14	X	X			X	X	X	X	X	X					X	X							X	X	X	X		
15			X	X			X	X	X	X	X	X					X	X							X	X	X	X
20		X		X		X		X		X		X		X		X		X		X		X		X		X		X
21	X		X		X		X		X		X		X		X		X		X		X		X		X		X	

	000	100	200	300	400	500	600	700	800	900
16	X		X			X	X			
17		X		X			X	X		
18			X		X			X	X	
19				X		X			X	X

NOTE:
1. ALL SWITCHES SHOWN IN FRONT VIEW AT 118.0 MC POSITION. FREQUENCY INCREASES IN CLOCKWISE DIRECTION.
2. FRONT AND REAR ROTOR BLADES ARE INSULATED FROM EACH OTHER

KEY:
●→ FRONT CONTACTS
○→ REAR CONTACTS
◉→ FRONT AND REAR CONTACTS

Figure 12-12. 614F-2 Frequency Control Unit, Schematic


5670
V601
T601
T602
T603
0.2 MF
C601
C 602
0.2MF
C 603
0.1MF
C 604
0.1 MF
2 MF
C605
R601
470
R602 270 K
R603 270 K
R604 2700
R605 2700
R606
1500
150 V
115 V
26 V
6.3 V
E601
J601
P 601

THIS PORTION OF WIRING INCLUDED IN MOUNTING BASE FOR 333B- 3 ONLY.

Figure 12-13. Type 333B-1, 3 Servo Amplifier, Schematic

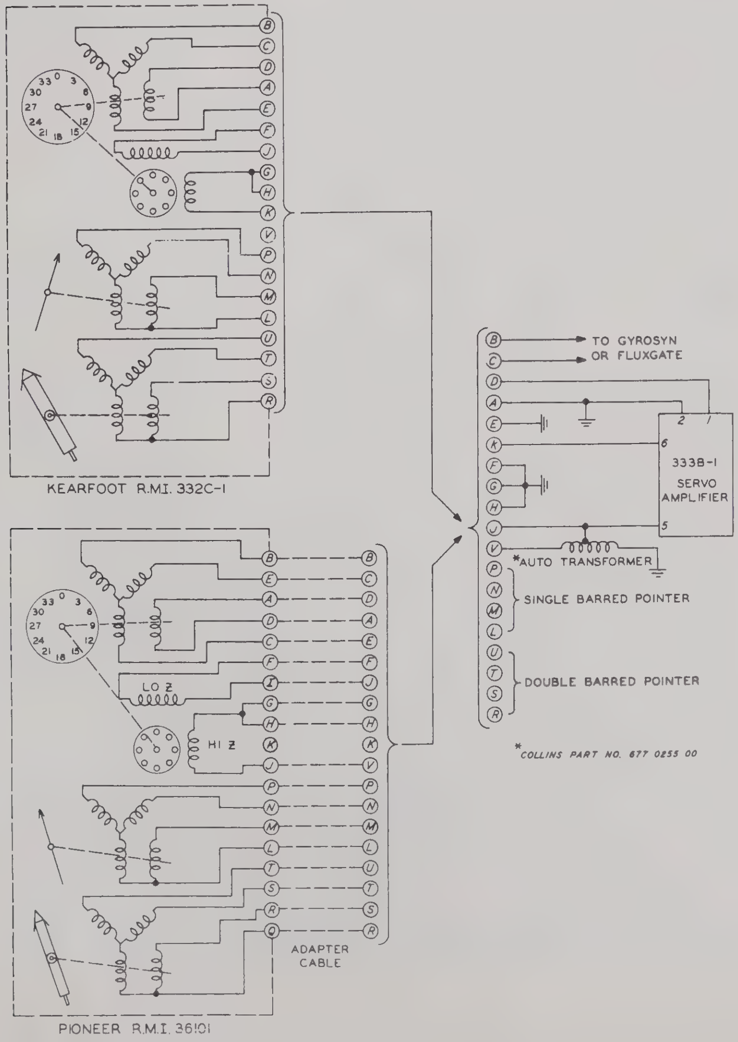

KEARFOOT R.M.I. 332C-1
TO GYROSYN
OR FLUXGATE
333B-1
SERVO
AMPLIFIER
*AUTO TRANSFORMER
SINGLE BARRED POINTER
DOUBLE BARRED POINTER
*COLLINS PART NO. 677 0255 00
LO Z
HI Z
ADAPTER
CABLE
PIONEER R.M.I. 36101

Figure 12-14. Kearfott and Pioneer Radio Magnetic Indicator Connections

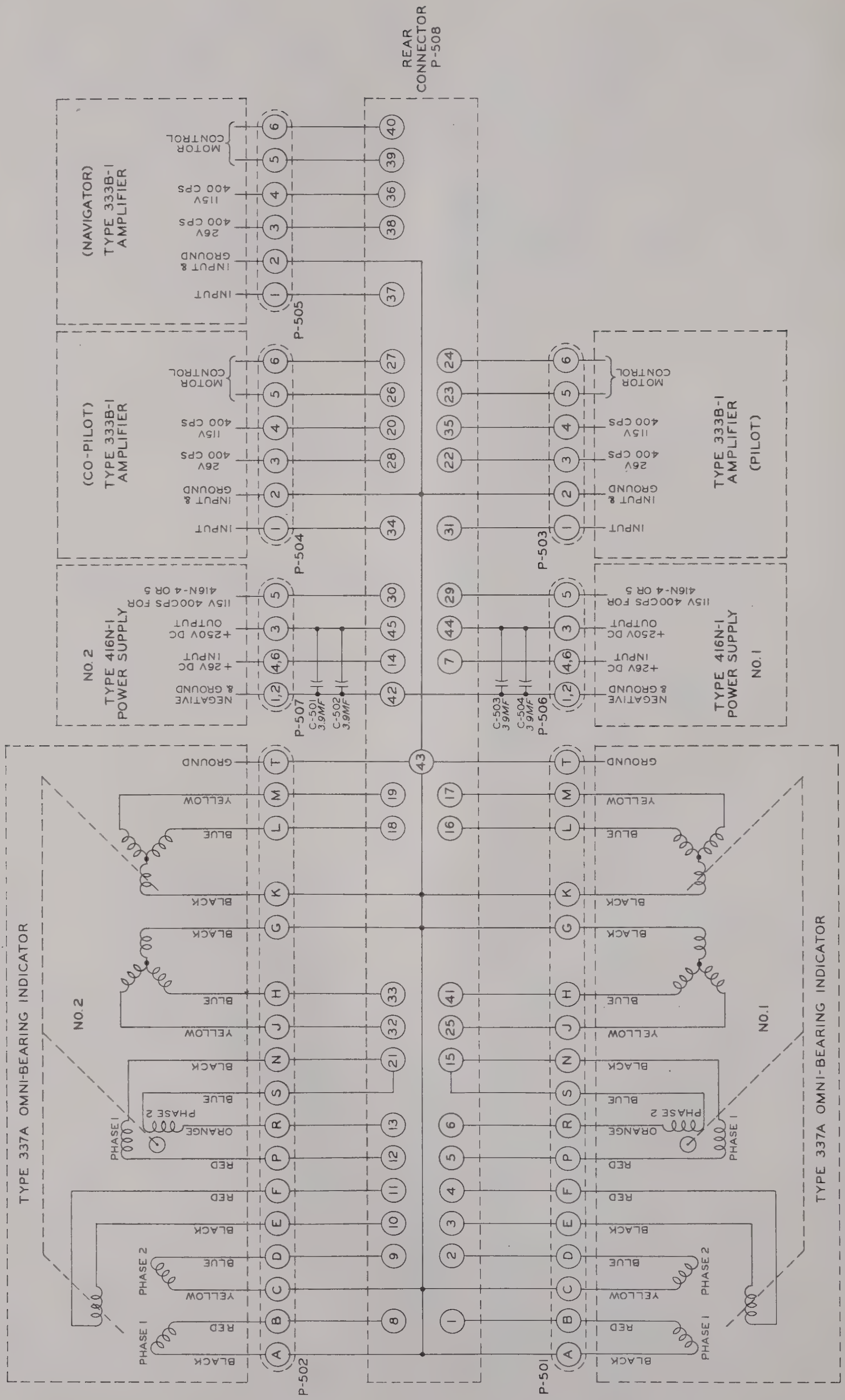
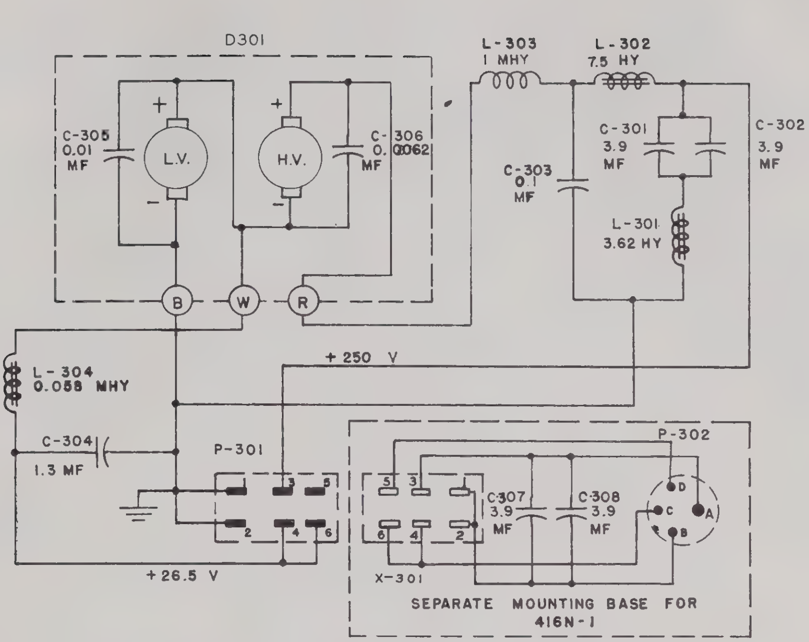

REAR CONNECTOR P-508
(NAVIGATOR) TYPE 333B-1 AMPLIFIER
(CO-PILOT) TYPE 333B-1 AMPLIFIER
TYPE 333B-1 AMPLIFIER (PILOT)
NO. 2 TYPE 416N-1 POWER SUPPLY
TYPE 416N-1 POWER SUPPLY NO. 1
TYPE 337A OMNI-BEARING INDICATOR NO. 2
TYPE 337A OMNI-BEARING INDICATOR NO. 1
INPUT
INPUT & GROUND
26V 400 CPS
115V 400 CPS
MOTOR CONTROL
NEGATIVE & GROUND
+26V DC INPUT
+250V DC OUTPUT
115V 400CPS FOR 416N-4 OR 5
GROUND
YELLOW
BLUE
BLACK
ORANGE
RED
PHASE 1
PHASE 2
P-501
P-502
P-503
P-504
P-505
P-506
P-507
C-501 3.9MF
C-502 3.9MF
C-503 3.9MF
C-504 3.9MF

Figure 12-15. Type 351A-1 Accessory Frame, Connection Diagram


D301
L-303
1 MHY
L-302
7.5 HY
C-305
0.01
MF
L.V.
H.V.
C-306
0.0062
MF
C-301
3.9
MF
C-302
3.9
MF
C-303
0.1
MF
L-301
3.62 HY
B
W
R
L-304
0.058 MHY
+250 V
C-304
1.3 MF
P-301
P-302
C-307
3.9
MF
C-308
3.9
MF
D
C
A
B
X-301
+26.5 V
SEPARATE MOUNTING BASE FOR
416N-1

NOTE: THE 351A-1 ACCESSORY UNIT INCLUDES FOUR 3.9MF CAPACITORS (TWO FOR EACH POWER SUPPLY) PROVIDING FILTERING EQUIVALENT TO C-307 & C-308 ABOVE.

Figure 12-16. Type 416N-1 Power Supply, Schematic

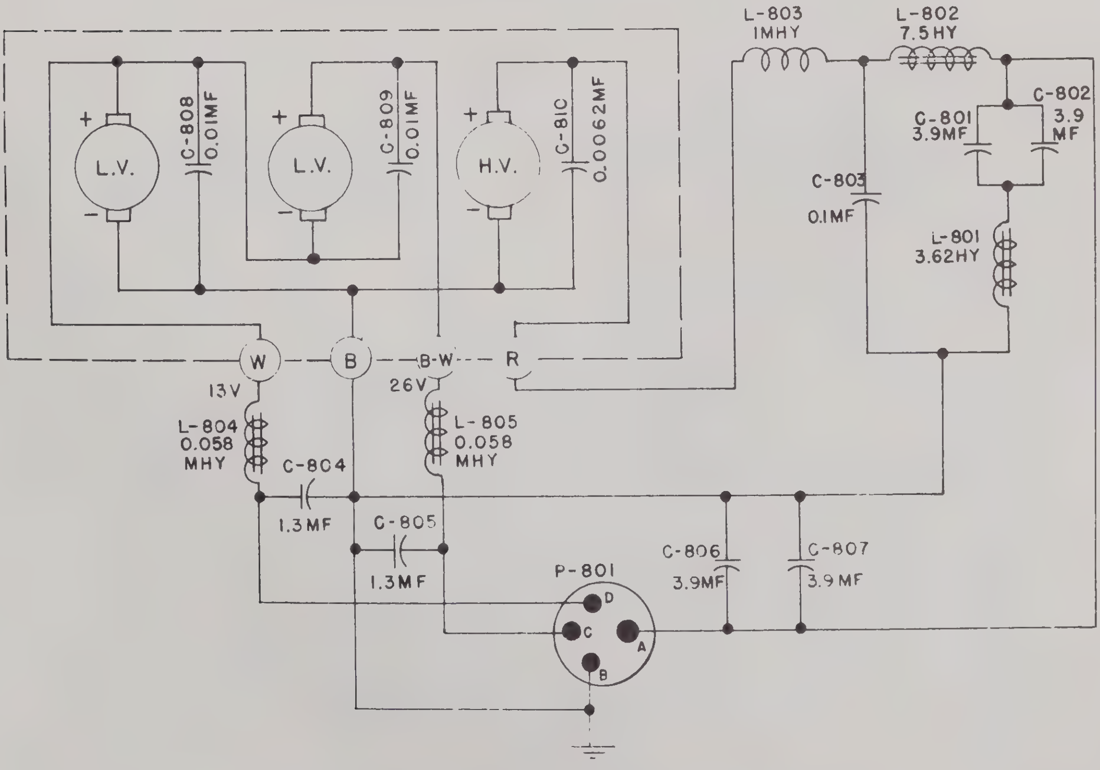

L-803
1MHY
L-802
7.5HY
L.V.
C-808
0.01MF
L.V.
C-809
0.01MF
H.V.
C-810
0.0062MF
C-802
3.9
MF
C-801
3.9MF
C-803
0.1MF
L-801
3.62HY
W
B
B-W
R
13V
26V
L-804
0.058
MHY
L-805
0.058
MHY
C-804
1.3MF
C-805
1.3MF
C-806
3.9MF
C-807
3.9 MF
P-801
D
C
A
B

Figure 12-17. Type 416N-2 Power Supply, Schematic

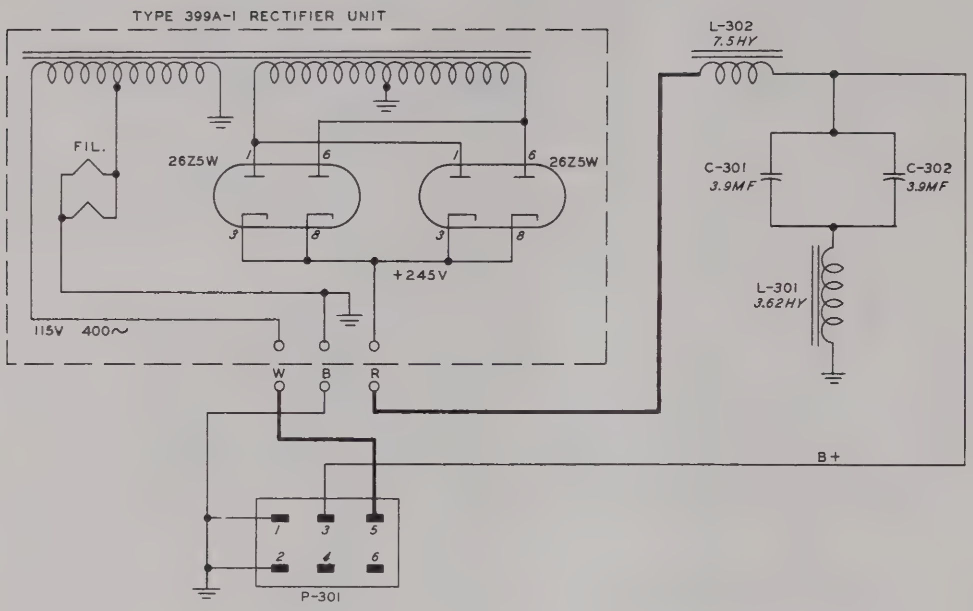

TYPE 399A-1 RECTIFIER UNIT
L-302
7.5HY
FIL.
26Z5W
1
6
1
6
26Z5W
3
8
3
8
+245V
115V 400~
C-301
3.9MF
C-302
3.9MF
L-301
3.62HY
W
B
R
B+
1
3
5
2
4
6
P-301

Figure 12-18. Type 416N-4 Power Supply, Schematic

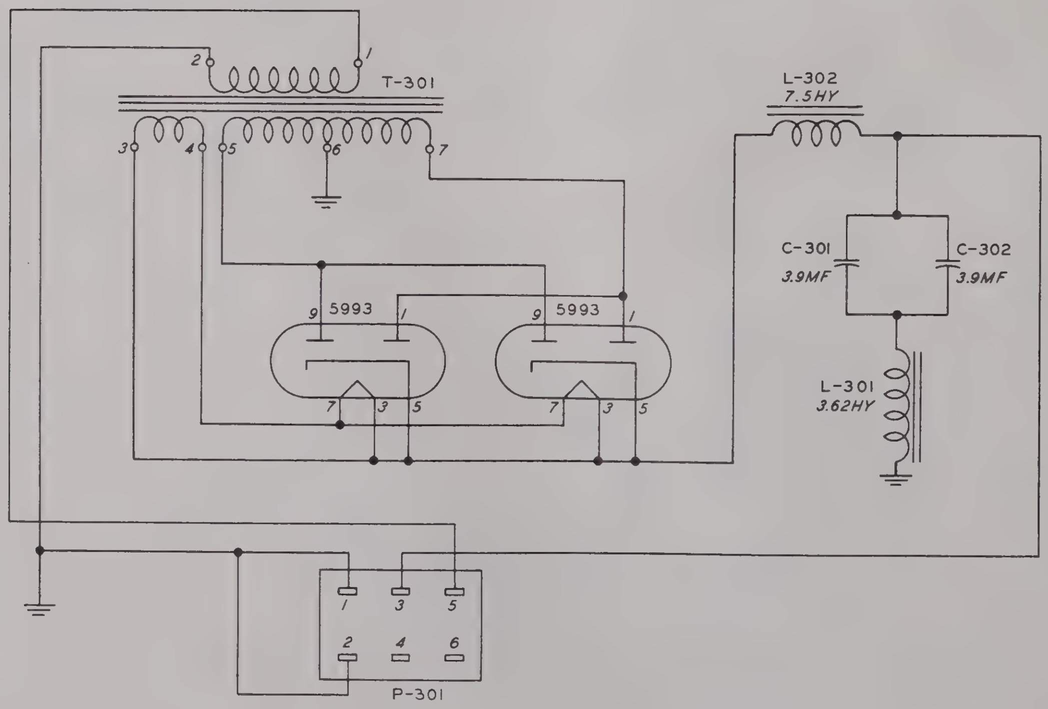

2
1
T-301
3
4
5
6
7
L-302
7.5HY
C-301
3.9MF
C-302
3.9MF
9
5993
1
9
5993
1
7
3
5
7
3
5
L-301
3.62HY
1
3
5
2
4
6
P-301

Figure 12-19. Type 416N-5 Power Supply, Schematic

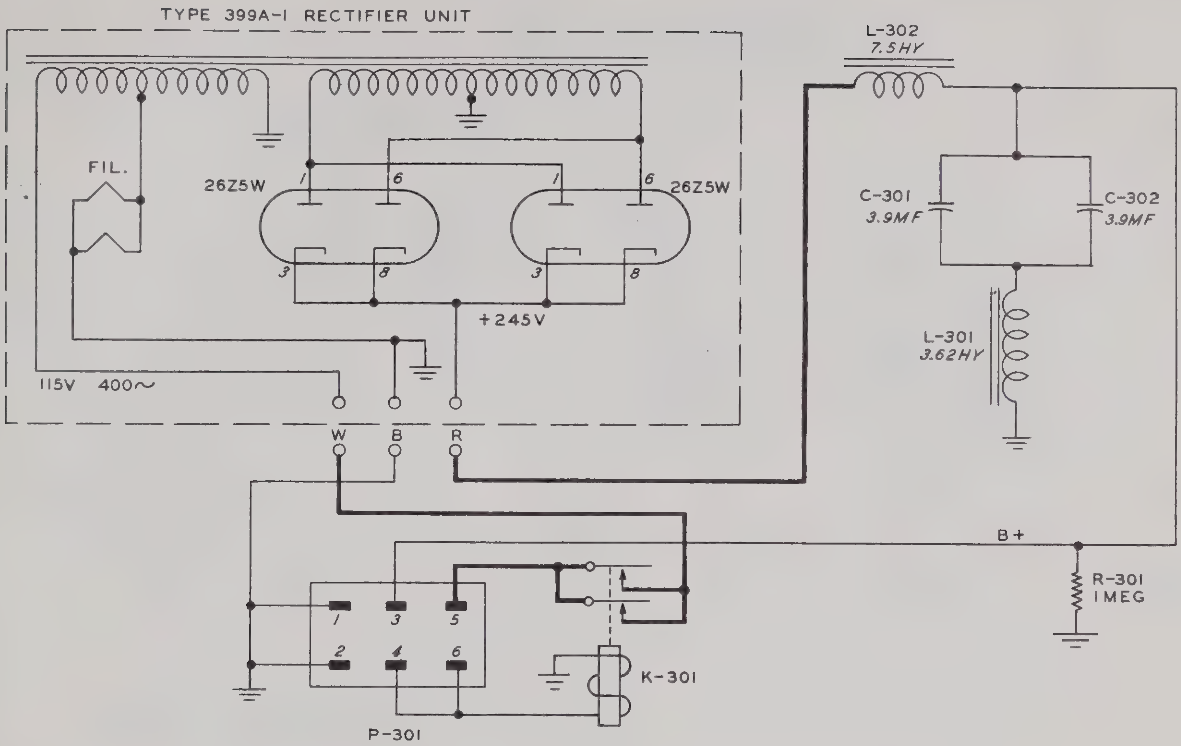

TYPE 399A-1 RECTIFIER UNIT
FIL.
26Z5W
26Z5W
1
6
1
6
3
8
3
8
+245V
115V 400~
W
B
R
L-302
7.5HY
C-301
3.9MF
C-302
3.9MF
L-301
3.62HY
B+
R-301
1MEG
1
3
5
2
4
6
K-301
P-301

Figure 12-20. Type 146N-4 Power Supply Schematic, Modification with AC Hold Relay

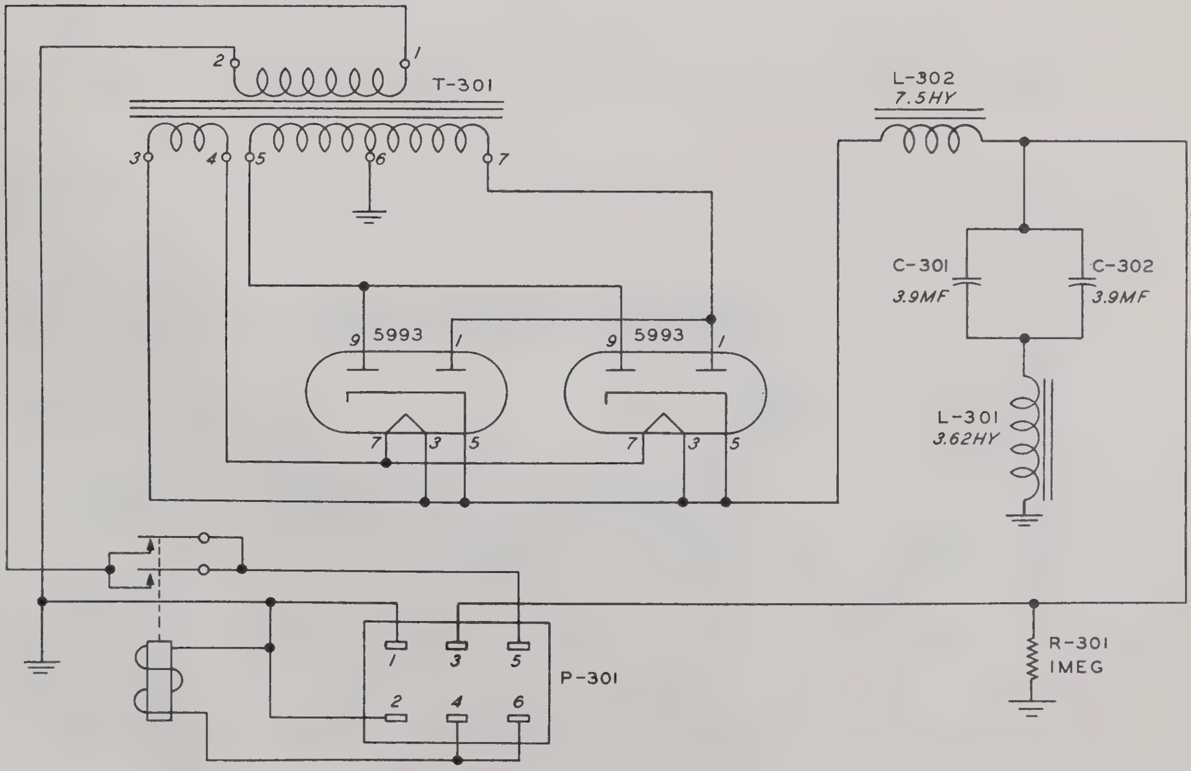
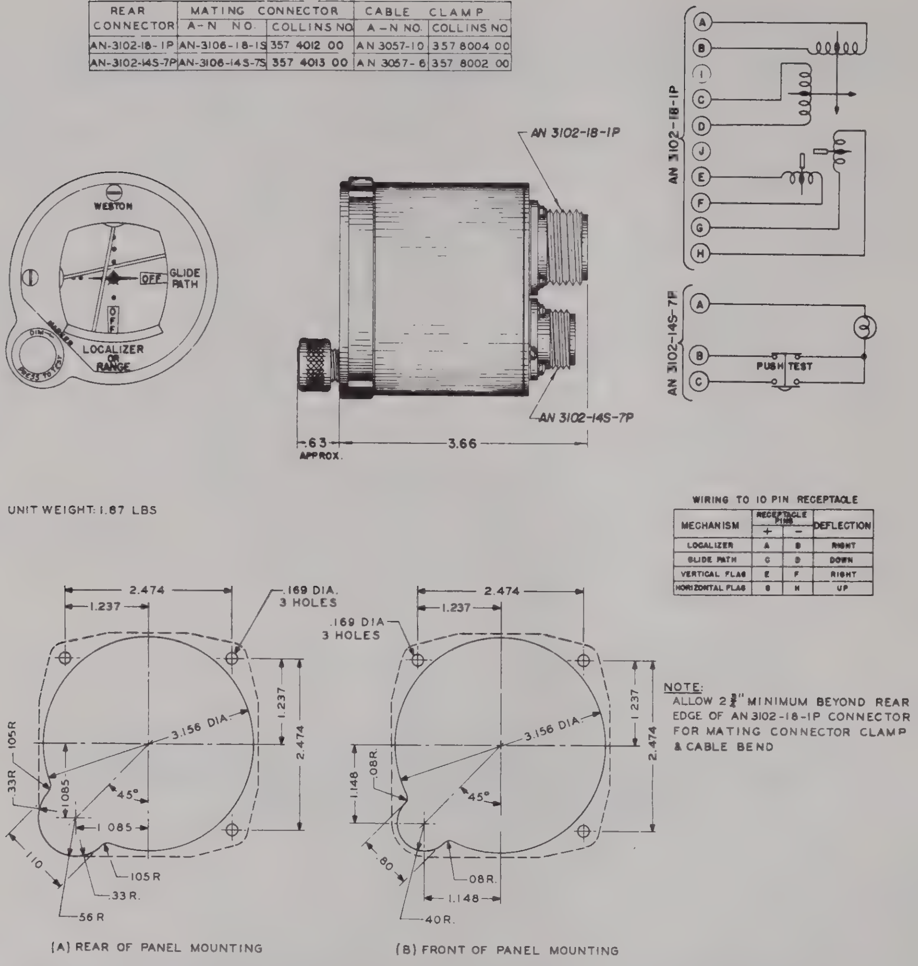

2
1
T-301
3
4
5
6
7
L-302
7.5HY
C-301
3.9MF
C-302
3.9MF
9
5993
1
9
5993
1
7
3
5
7
3
5
L-301
3.62HY
1
3
5
2
4
6
P-301
R-301
1MEG

Figure 12-21. Type 4-6N-5 Power Supply Schematic, Modification with AC Hold Relay

REAR CONNECTOR	MATING CONNECTOR		CABLE CLAMP	
	A-N NO.	COLLINS NO	A-N NO.	COLLINS NO
AN-3102-18-1P	AN-3106-18-1S	357 4012 00	AN 3057-10	357 8004 00
AN-3102-14S-7P	AN-3106-14S-7S	357 4013 00	AN 3057-6	357 8002 00


AN 3102-18-1P
WESTON
GLIDE PATH
OFF
LOCALIZER OR RANGE
DIM
MARKER
PRESS TO TEST
AN 3102-14S-7P
.63 APPROX.
3.66
A
B
C
D
E
F
G
H
PUSH TEST
2.474
1.237
.169 DIA. 3 HOLES
3.156 DIA.
.105R
.33R
1085
1 085
45°
.110
.56 R
.08R
1.148
.80
.40R

UNIT WEIGHT: 1.87 LBS

WIRING TO 10 PIN RECEPTACLE

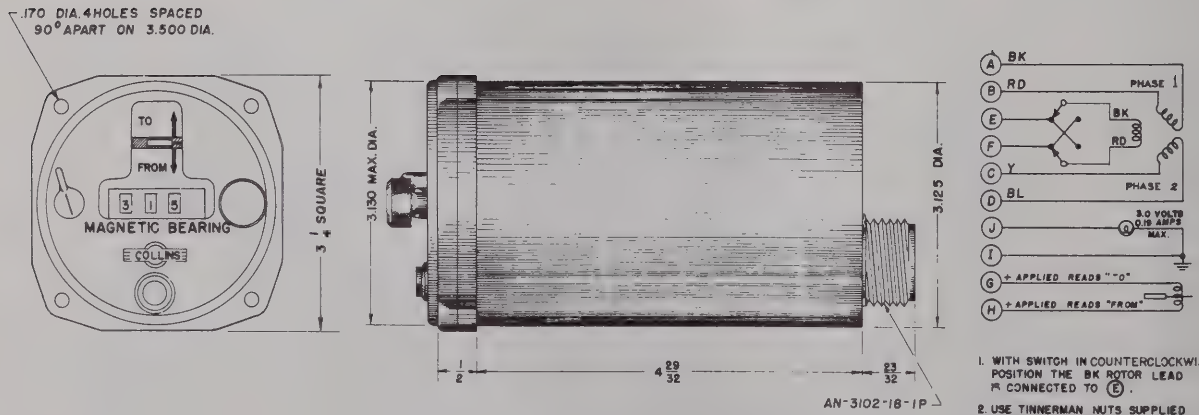
MECHANISM	RECEPTACLE PINS		DEFLECTION
	+	−	
LOCALIZER	A	B	RIGHT
GLIDE PATH	C	D	DOWN
VERTICAL FLAG	E	F	RIGHT
HORIZONTAL FLAG	G	H	UP

NOTE:
ALLOW 2$\frac{3}{4}$" MINIMUM BEYOND REAR EDGE OF AN 3102-18-1P CONNECTOR FOR MATING CONNECTOR CLAMP & CABLE BEND

(A) REAR OF PANEL MOUNTING

(B) FRONT OF PANEL MOUNTING

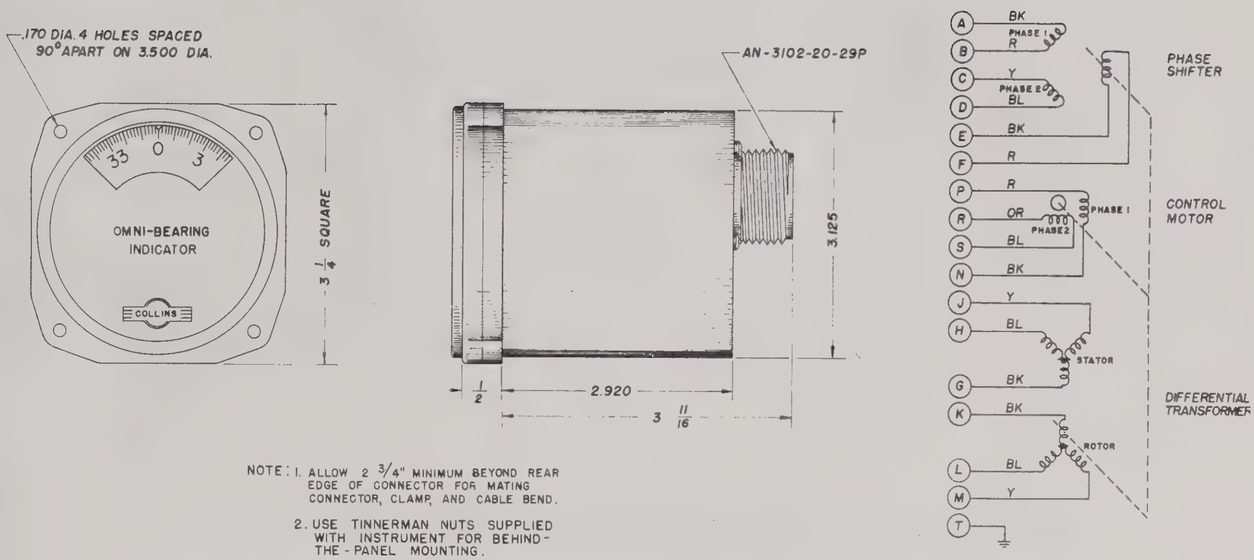
Figure 12-22. Deviation Indicator ID-48, Outline Drawing and Schematic


.170 DIA. 4 HOLES SPACED 90° APART ON 3.500 DIA.
TO
FROM
3 1 5
MAGNETIC BEARING
COLLINS
3 1/4 SQUARE
3.130 MAX. DIA.
3.125 DIA.
1/2
4 29/32
23/32
AN-3102-18-1P
BK
RD
Y
BL
PHASE 1
PHASE 2
3.0 VOLTS 0.19 AMPS MAX.
+ APPLIED READS "TO"
+ APPLIED READS "FROM"

1. WITH SWITCH IN COUNTERCLOCKWISE POSITION THE BK ROTOR LEAD IS CONNECTED TO Ⓔ.
2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.
3. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 12-23. Type 336A-2 Omni-Bearing Selector, Outline Drawing and Schematic

REAR CONNECTOR	MATING CONNECTOR		CABLE CLAMP	
	A-N NO.	COLLINS NO.	A-N NO.	COLLINS NO.
AN-3102-20-29P	AN-3106-20-29S	357 4004 00	AN-3057-12	357 8005 00

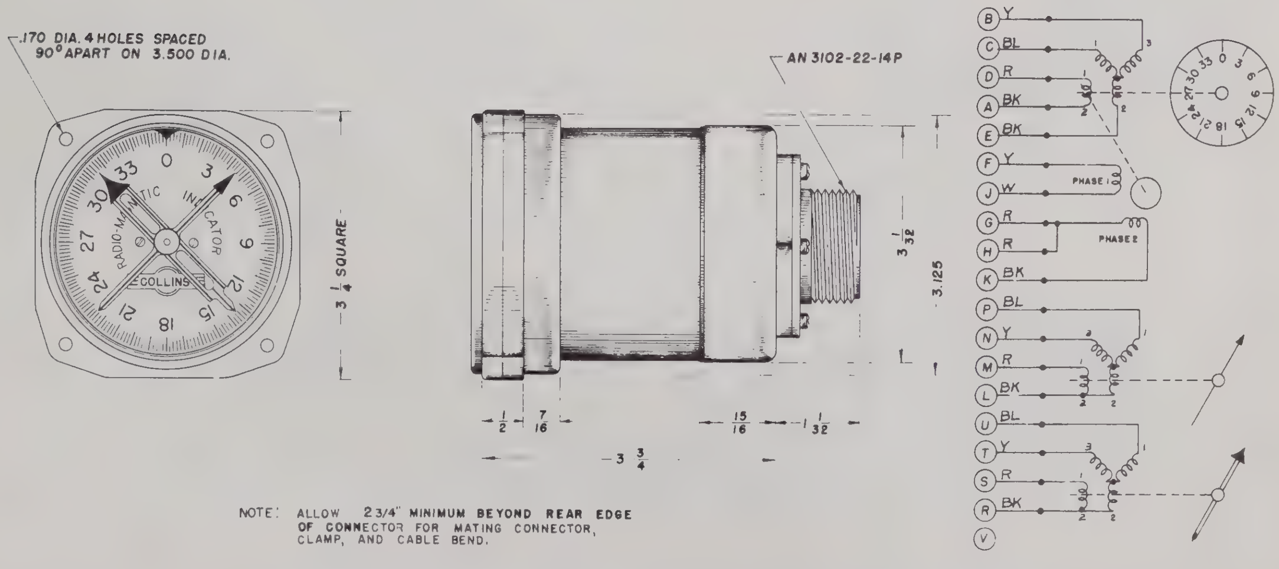

.170 DIA. 4 HOLES SPACED 90° APART ON 3.500 DIA.
33 0 3
OMNI-BEARING INDICATOR
COLLINS
3 1/4 SQUARE
AN-3102-20-29P
3.125
1/2
2.920
3 11/16
A BK
PHASE 1
B R
C Y
PHASE 2
D BL
E BK
F R
PHASE SHIFTER
P R
R OR
PHASE 1
PHASE 2
S BL
N BK
CONTROL MOTOR
J Y
H BL
STATOR
G BK
K BK
ROTOR
L BL
M Y
T
DIFFERENTIAL TRANSFORMER

NOTE: 1. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.

Figure 12-24. Type 337A-2 Omni-Bearing Indicator, Outline Drawing and Schematic

REAR CONNECTOR	MATING CONNECTOR		CABLE CLAMP	
	A-N NO.	COLLINS No.	A-N NO.	COLLINS NO.
AN-3102-22-14P	AN-3106-22-14S	357 4005 00	AN-3057-12	357 8005 00


.170 DIA. 4 HOLES SPACED 90° APART ON 3.500 DIA.
RADIO-MAGNETIC INDICATOR
COLLINS
0 3 6 9 12 15 18 21 24 27 30 33
3 1/4 SQUARE
AN 3102-22-14P
3 1/32
3.125
1/2
7/16
15/16
1 1/32
3 3/4
B Y
C BL
D R
A BK
E BK
F Y
J W
PHASE 1
G R
H R
PHASE 2
K BK
P BL
N Y
M R
L BK
U BL
T Y
S R
R BK
V
1
2
3

NOTE: ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 12-25. Type 332C-2 Radio Magnetic Indicator, Outline Drawing and Schematic

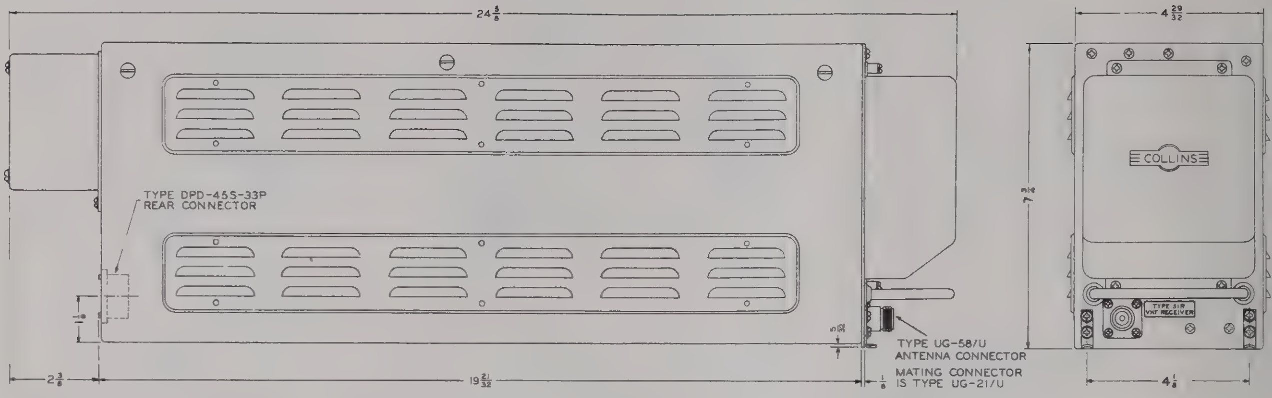
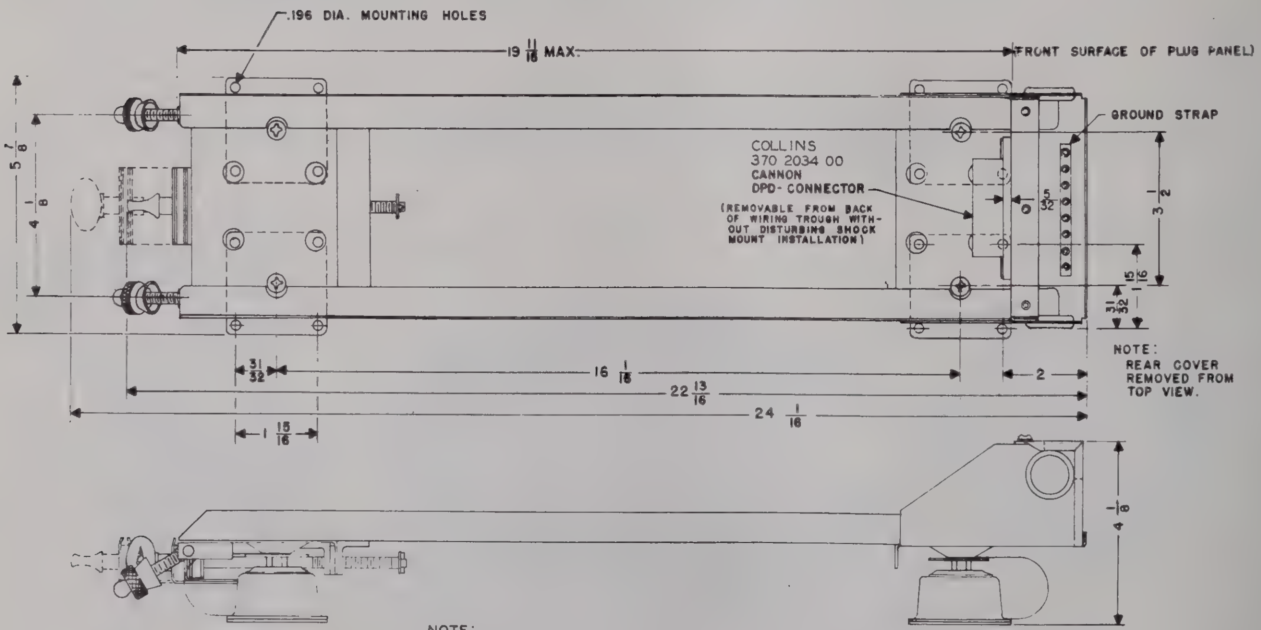

24 5/8
4 29/32
COLLINS
TYPE DPD-45S-33P
REAR CONNECTOR
7 3/4
1 1/8
5/32
TYPE UG-58/U
ANTENNA CONNECTOR
MATING CONNECTOR
IS TYPE UG-21/U
2 3/8
19 21/32
1/8
4 1/8

Figure 12-26. Type 51R-3 Navigation Receiver, Outline Drawing


.196 DIA. MOUNTING HOLES
19 11/16 MAX.
(FRONT SURFACE OF PLUG PANEL)
GROUND STRAP
5 7/8
4 1/8
COLLINS
370 2034 00
CANNON
DPD- CONNECTOR
(REMOVABLE FROM BACK OF WIRING TROUGH WITHOUT DISTURBING SHOCK MOUNT INSTALLATION)
5/32
3 1/2
15/16
31/32
31/32
16 1/16
2
22 13/16
24 1/16
1 15/16
4 1/8

NOTE:
REAR COVER
REMOVED FROM
TOP VIEW.

NOTE:
CENTER-LINE OF REAR PLUG
SHALL BE 1 5/32 MIN. ABOVE
SURFACE OF SIDE RAILS.

Figure 12-27. Shockmount, Outline Drawing

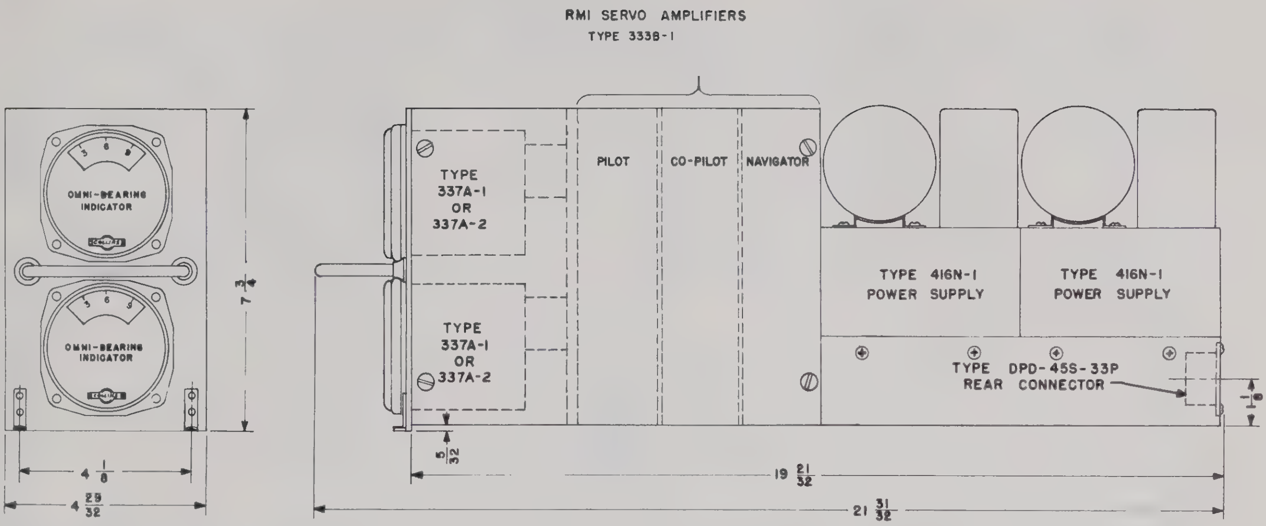
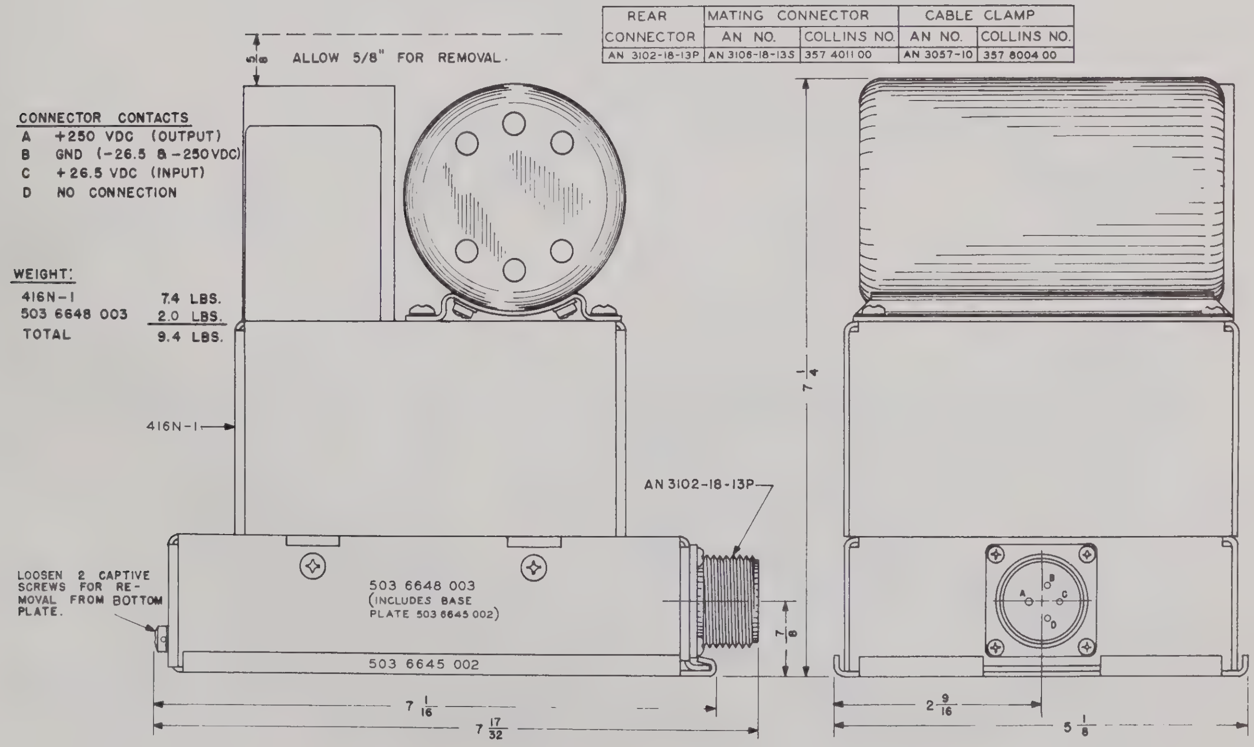

RMI SERVO AMPLIFIERS
TYPE 333B-1
OMNI-BEARING INDICATOR
OMNI-BEARING INDICATOR
TYPE 337A-1 OR 337A-2
TYPE 337A-1 OR 337A-2
PILOT
CO-PILOT
NAVIGATOR
TYPE 416N-1 POWER SUPPLY
TYPE 416N-1 POWER SUPPLY
TYPE DPD-45S-33P REAR CONNECTOR
7 3/4
1 1/8
5/32
4 1/8
4 29/32
19 21/32
21 31/32

Figure 12-28. Type 351A-1, Accessory Frame, Outline Drawing



REAR	MATING CONNECTOR		CABLE CLAMP	
CONNECTOR	AN NO.	COLLINS NO.	AN NO.	COLLINS NO.
AN 3102-18-13P	AN 3106-18-13S	357 4011 00	AN 3057-10	357 8004 00

CONNECTOR CONTACTS

A	+250 VDC (OUTPUT)
B	GND (-26.5 & -250VDC)
C	+26.5 VDC (INPUT)
D	NO CONNECTION

WEIGHT:

416N-1	7.4 LBS.
503 6648 003	2.0 LBS.
TOTAL	9.4 LBS.

LOOSEN 2 CAPTIVE SCREWS FOR REMOVAL FROM BOTTOM PLATE.

ALLOW 5/8" FOR REMOVAL.
5/8
416N-1
AN 3102-18-13P
503 6648 003 (INCLUDES BASE PLATE 503 6645 002)
503 6645 002
7/8
7 1/4
7 1/16
7 17/32
2 9/16
5 1/8
A
B
C
D

Figure 12-29. Type 416N-1 Power Supply, Outline Drawing

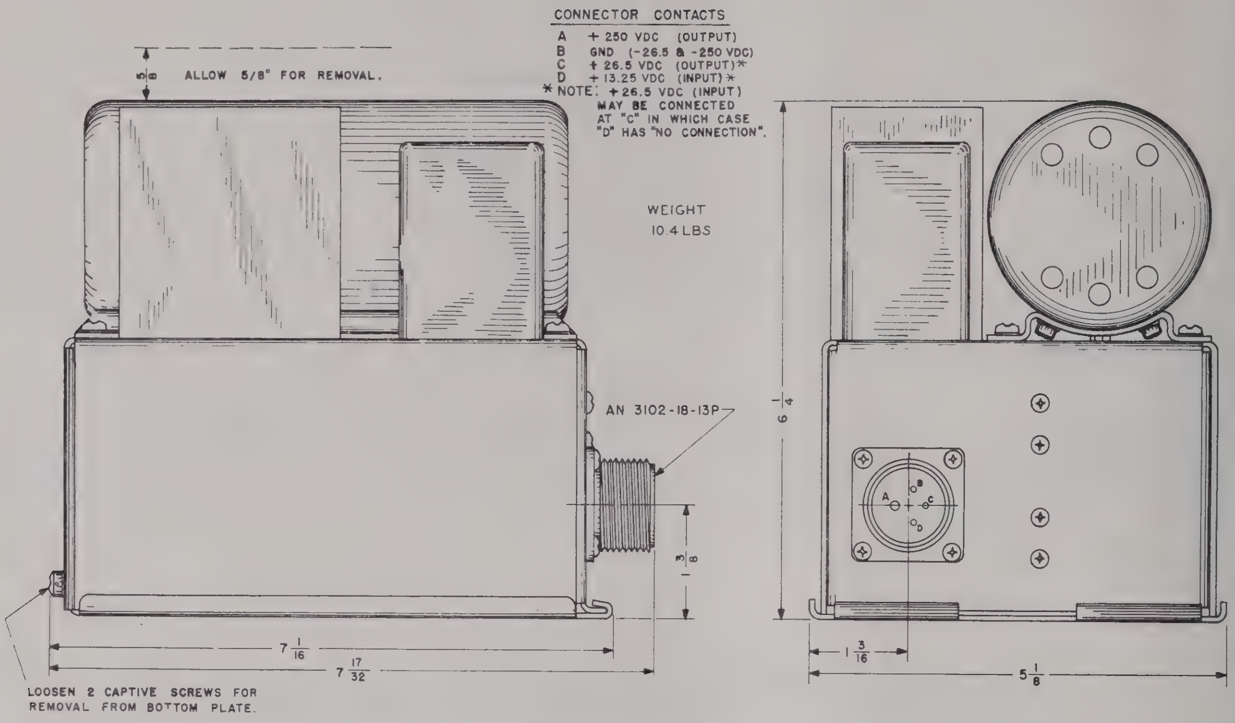

CONNECTOR CONTACTS
A + 250 VDC (OUTPUT)
B GND (-26.5 & -250 VDC)
C + 26.5 VDC (OUTPUT)*
D + 13.25 VDC (INPUT)*
* NOTE: + 26.5 VDC (INPUT) MAY BE CONNECTED AT "C" IN WHICH CASE "D" HAS "NO CONNECTION".
5/8
ALLOW 5/8" FOR REMOVAL.
WEIGHT 10.4 LBS
AN 3102-18-13P
1 3/8
6 1/4
7 1/16
7 17/32
LOOSEN 2 CAPTIVE SCREWS FOR REMOVAL FROM BOTTOM PLATE.
1 3/16
5 1/8
A
B
C
D

Figure 12-30. Type 416N-2 Power Supply, Outline Drawing

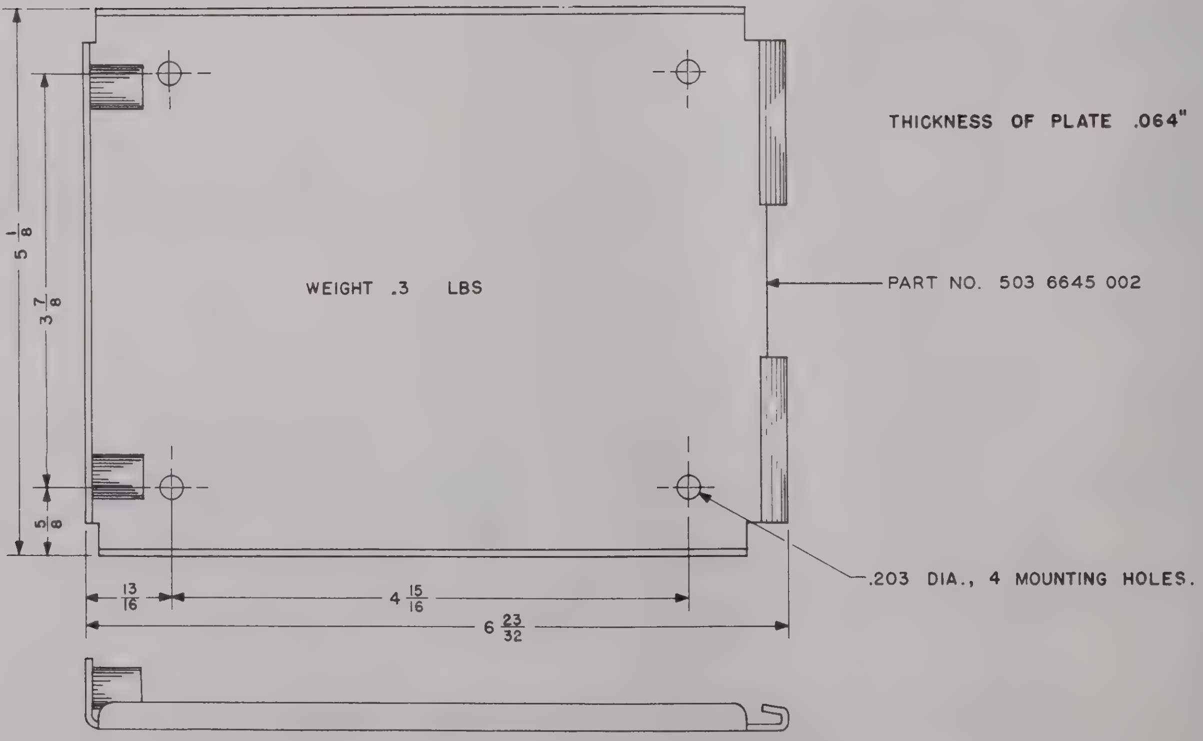
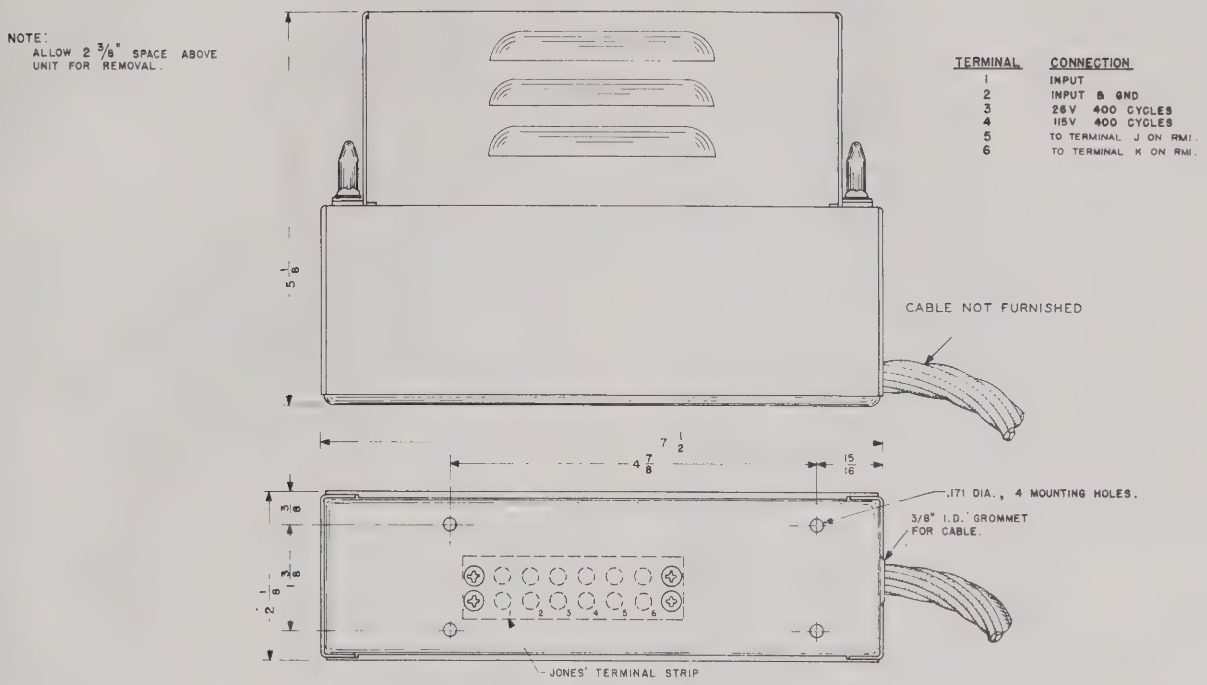

THICKNESS OF PLATE .064"
WEIGHT .3 LBS
PART NO. 503 6645 002
5 1/8
3 7/8
5/8
.203 DIA., 4 MOUNTING HOLES.
13/16
4 15/16
6 23/32

Figure 12-31. Mounting Base for 416N-2 Power Supply, Outline Drawing



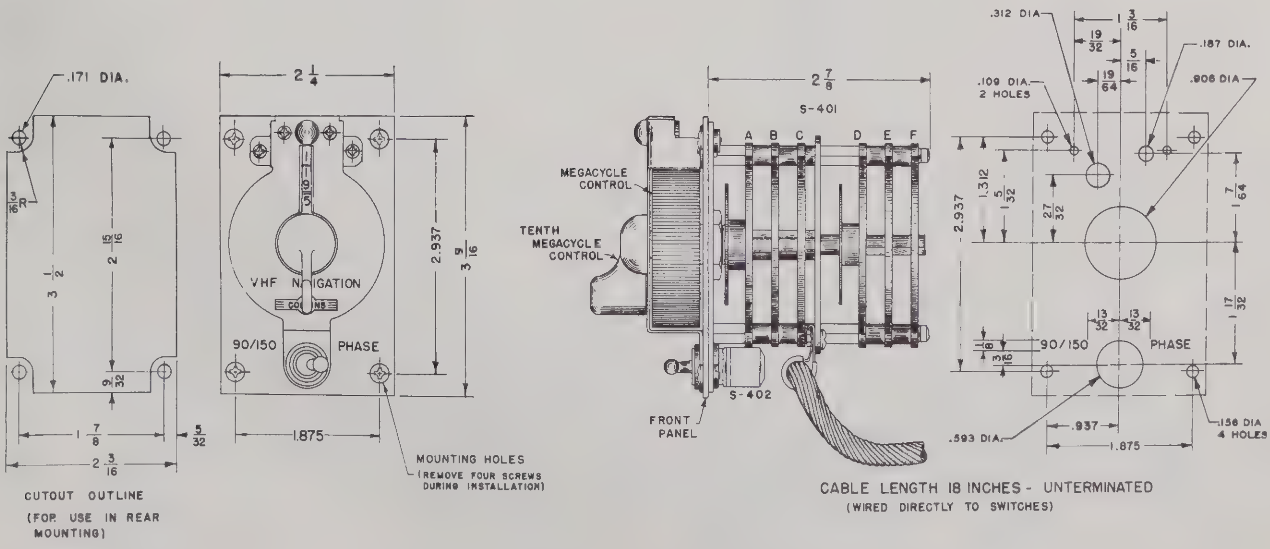
NOTE:
ALLOW 2 3/8" SPACE ABOVE UNIT FOR REMOVAL.

TERMINAL	CONNECTION
1	INPUT
2	INPUT & GND
3	26V 400 CYCLES
4	115V 400 CYCLES
5	TO TERMINAL J ON RMI.
6	TO TERMINAL K ON RMI.

5 1/8
CABLE NOT FURNISHED
7 1/2
4 7/8
15/16
3/8
1 3/8
2 1/8
.171 DIA., 4 MOUNTING HOLES.
3/8" I.D. GROMMET FOR CABLE.
1
2
3
4
5
6
JONES' TERMINAL STRIP

Figure 12-32. Type 333B-3, Servo Amplifier, Outline Drawing

NOTE: 1. UNIT MAY BE MOUNTED FROM REAR OF CUSTOMERS PANEL USING CUTOUT SHOWN. WHERE UNIT FRONT PANEL IS REPLACED BY SEPARATE PANEL, USE LAYOUT SHOWN AT RIGHT, PANEL MUST BE 1/16" THICK.

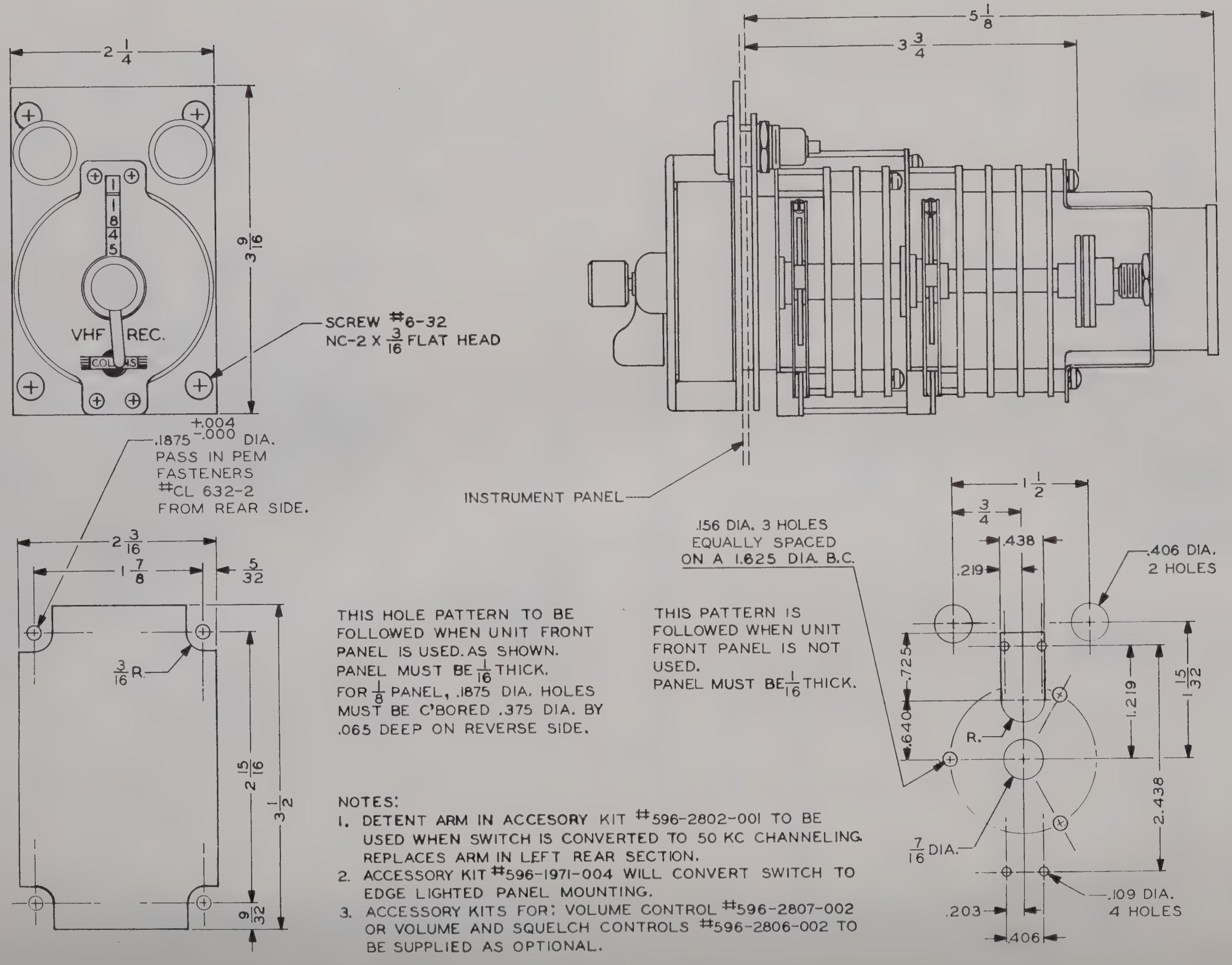


.171 DIA.
3/16 R
3 1/2
2 15/16
9/32
1 7/8
5/32
2 3/16
2 1/4
VHF NAVIGATION
COLLINS
90/150
PHASE
2.937
3 9/16
1.875
MOUNTING HOLES (REMOVE FOUR SCREWS DURING INSTALLATION)
2 7/8
S-401
A B C D E F
MEGACYCLE CONTROL
TENTH MEGACYCLE CONTROL
S-402
FRONT PANEL
.312 DIA
1 3/16
19/32
5/16
19/64
.187 DIA.
.109 DIA. 2 HOLES
.906 DIA
2.937
1.312
1 5/32
27/32
1 7/64
1 17/32
13/32
13/32
1/8
3/16
90/150
PHASE
.593 DIA.
.937
1.875
.156 DIA 4 HOLES

CUTOUT OUTLINE (FOR USE IN REAR MOUNTING)

CABLE LENGTH 18 INCHES - UNTERMINATED (WIRED DIRECTLY TO SWITCHES)

Figure 12-33. Type 314U-1, 5 Frequency Control Unit, Outline Drawing


2 1/4
3 9/16
VHF
REC.
1 1/8 4 5
COLLINS
SCREW #6-32 NC-2 X 3/16 FLAT HEAD
.1875 +.004 -.000 DIA. PASS IN PEM FASTENERS #CL 632-2 FROM REAR SIDE.
2 3/16
1 7/8
5/32
3/16 R.
2 15/16
3 1/2
9/32
5 1/8
3 3/4
INSTRUMENT PANEL
.156 DIA. 3 HOLES EQUALLY SPACED ON A 1.625 DIA. B.C.
1 1/2
3/4
.438
.219
.406 DIA. 2 HOLES
.725
.640
R.
1.219
1 15/32
2.438
7/16 DIA.
.109 DIA. 4 HOLES
.203
.406

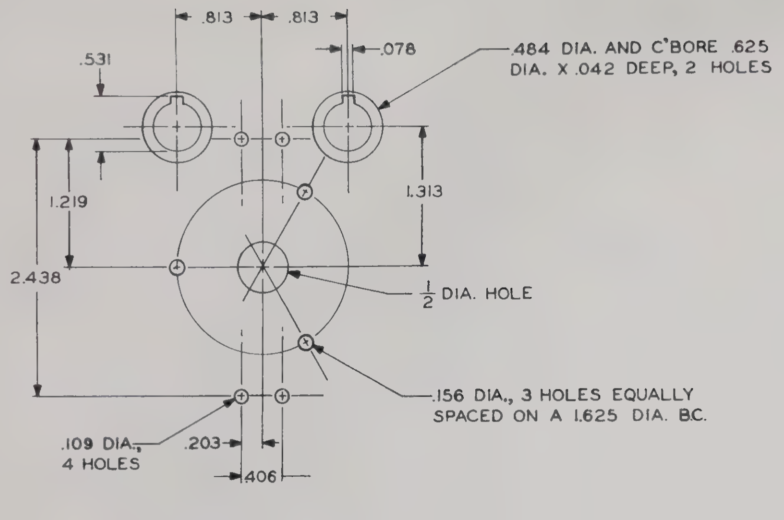
THIS HOLE PATTERN TO BE FOLLOWED WHEN UNIT FRONT PANEL IS USED. AS SHOWN. PANEL MUST BE 1/16 THICK. FOR 1/8 PANEL, .1875 DIA. HOLES MUST BE C'BORED .375 DIA. BY .065 DEEP ON REVERSE SIDE.

THIS PATTERN IS FOLLOWED WHEN UNIT FRONT PANEL IS NOT USED. PANEL MUST BE 1/16 THICK.

NOTES:

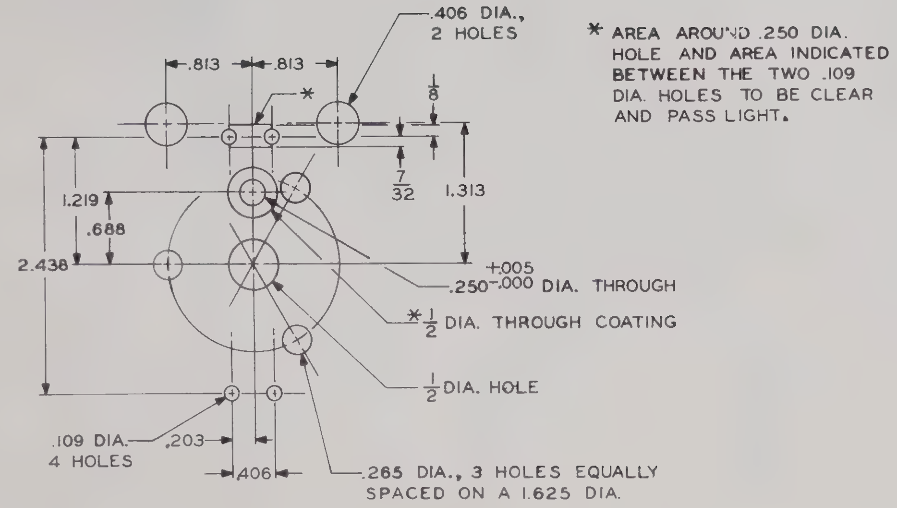
1. DETENT ARM IN ACCESORY KIT #596-2802-001 TO BE USED WHEN SWITCH IS CONVERTED TO 50 KC CHANNELING. REPLACES ARM IN LEFT REAR SECTION.
2. ACCESSORY KIT #596-1971-004 WILL CONVERT SWITCH TO EDGE LIGHTED PANEL MOUNTING.
3. ACCESSORY KITS FOR: VOLUME CONTROL #596-2807-002 OR VOLUME AND SQUELCH CONTROLS #596-2806-002 TO BE SUPPLIED AS OPTIONAL.

Figure 12-34. Type 314U-8, Control Unit, Outline Drawing

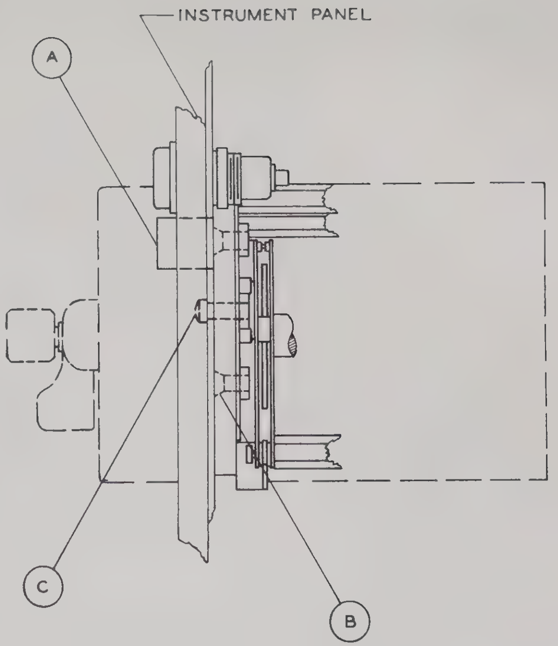

.813
.813
.531
.078
.484 DIA. AND C'BORE .625 DIA. X .042 DEEP, 2 HOLES
1.219
1.313
2.438
$\frac{1}{2}$ DIA. HOLE
.156 DIA., 3 HOLES EQUALLY SPACED ON A 1.625 DIA. BC.
.109 DIA., 4 HOLES
.203
.406

HOLE PATTERN IN ALUMINUM

HOLE PATTERN IN LUCITE


.406 DIA., 2 HOLES
.813
.813
*
$\frac{1}{8}$
$\frac{7}{32}$
1.313
1.219
.688
2.438
$.250^{+.005}_{-.000}$ DIA. THROUGH
* $\frac{1}{2}$ DIA. THROUGH COATING
$\frac{1}{2}$ DIA. HOLE
.109 DIA. 4 HOLES
.203
.406
.265 DIA., 3 HOLES EQUALLY SPACED ON A 1.625 DIA.

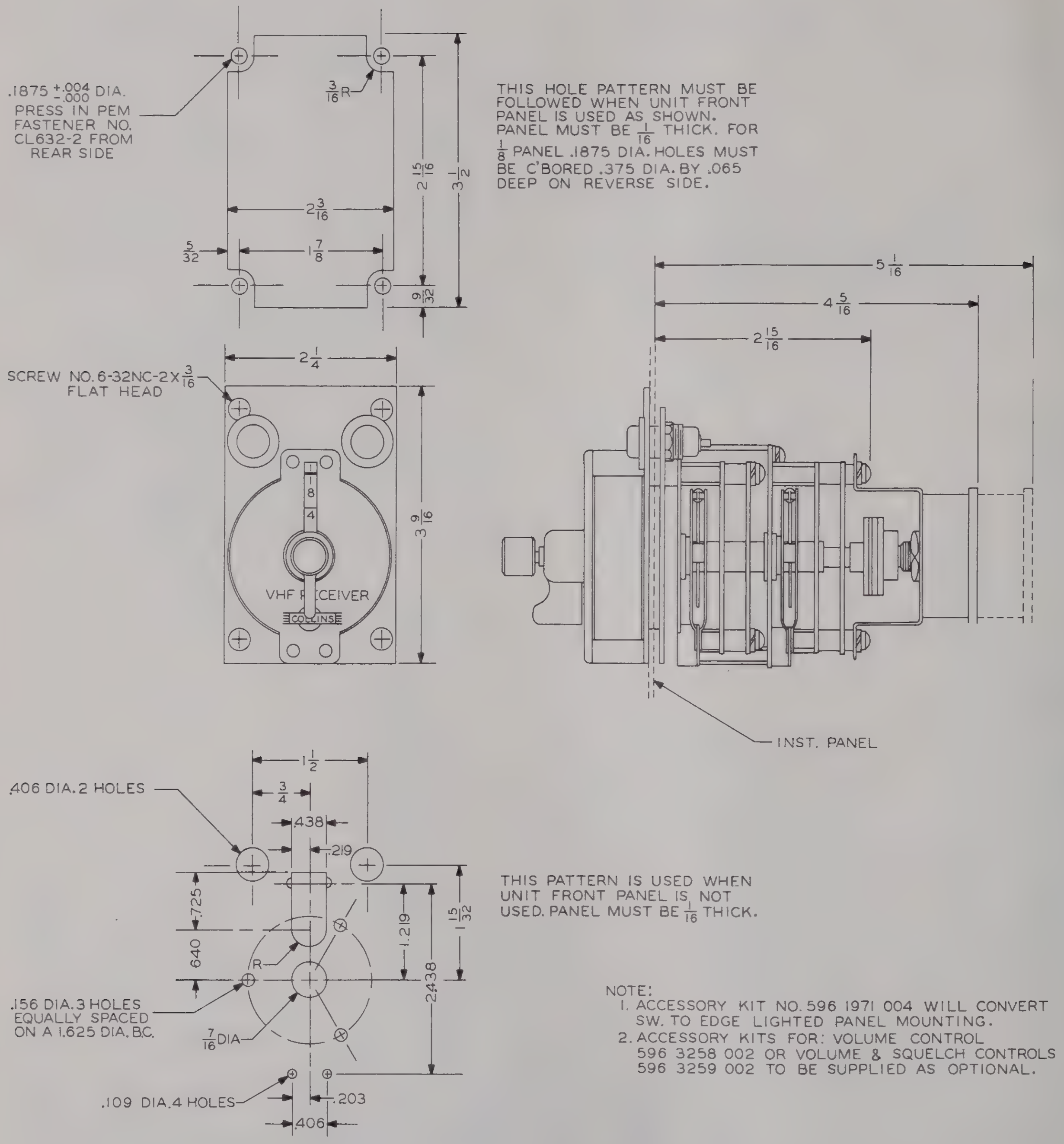
* AREA AROUND .250 DIA. HOLE AND AREA INDICATED BETWEEN THE TWO .109 DIA. HOLES TO BE CLEAR AND PASS LIGHT.


INSTRUMENT PANEL
A
B
C

NOTES: TO CONVERT SWITCH ASSEMBLY FOR EDGE LIGHTED PANEL INSTALLATION.

1. PREPARE METAL PANEL AND LUCITE PANEL AS SHOWN.
2. CEMENT IN PLACE, PILLAR, ITEM "A".
3. REMOVE MASK, KNOBS, FRONT AND REAR PANELS, AND SPACERS.
4. REMOUNT DIAMOND SHAPED SPACER WITH SCREWS, ITEM "B".
5. MOUNT SWITCH ON INSTRUMENT PANEL WITH SCREWS, ITEM "C".
6. REASSEMBLE KNOBS, MASK, AND LIGHTS

Figure 12-35. Type 314U-8, Control Unit, Accessory Kit

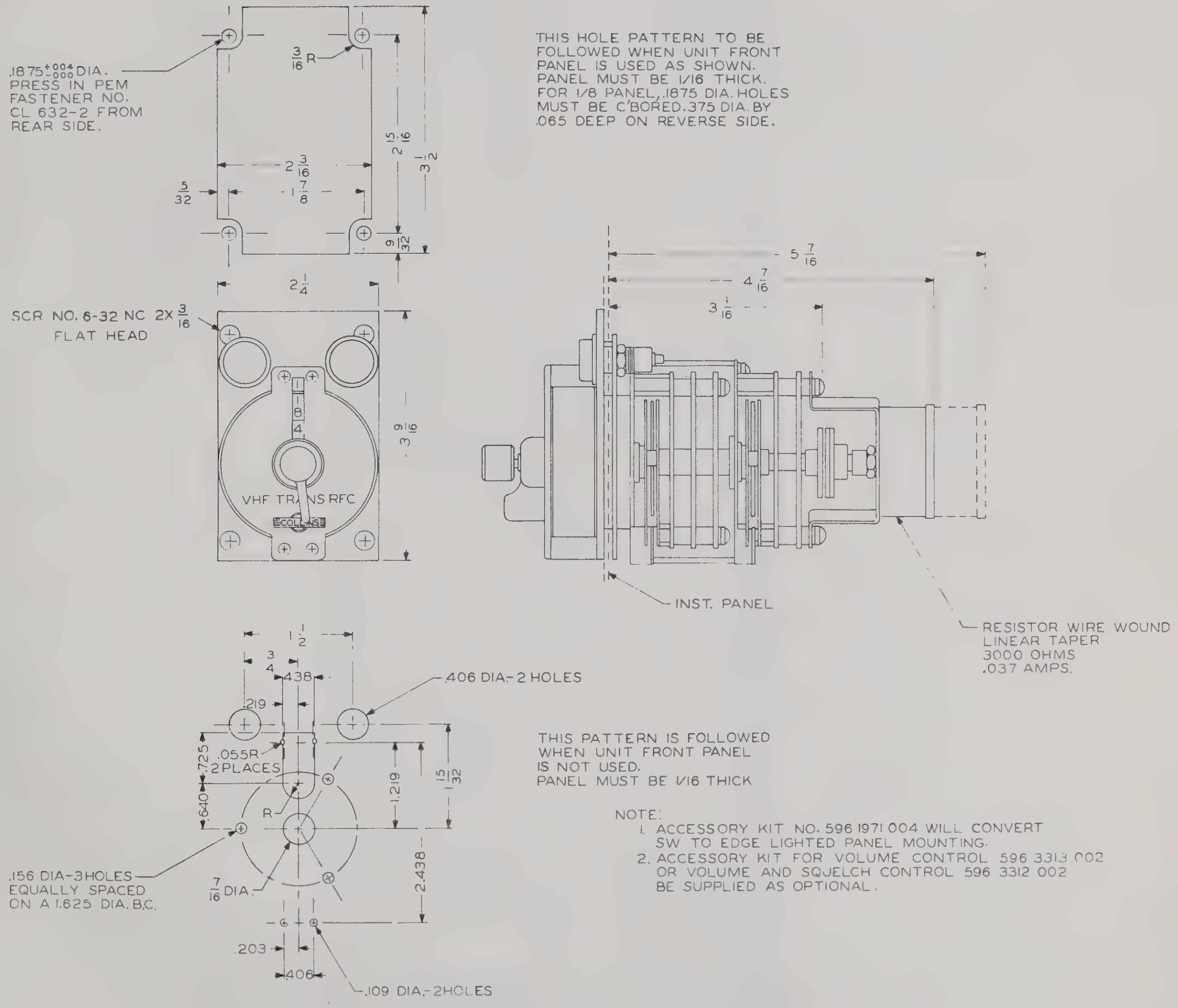

.1875 +.004 -.000 DIA.
PRESS IN PEM
FASTENER NO.
CL632-2 FROM
REAR SIDE
3/16 R
2 15/16
3 1/2
2 3/16
5/32
1 7/8
9/32
2 1/4
SCREW NO. 6-32NC-2X 3/16
FLAT HEAD
3 9/16
1
8
4
VHF RECEIVER
COLLINS
5 1/16
4 5/16
2 15/16
INST. PANEL
1 1/2
3/4
.406 DIA. 2 HOLES
.438
.219
.725
.640
R
1.219
1 15/32
2.438
.156 DIA. 3 HOLES
EQUALLY SPACED
ON A 1.625 DIA. B.C.
7/16 DIA
.109 DIA. 4 HOLES
.203
.406

THIS HOLE PATTERN MUST BE FOLLOWED WHEN UNIT FRONT PANEL IS USED AS SHOWN. PANEL MUST BE $\frac{1}{16}$ THICK. FOR $\frac{1}{8}$ PANEL .1875 DIA. HOLES MUST BE C'BORED .375 DIA. BY .065 DEEP ON REVERSE SIDE.

THIS PATTERN IS USED WHEN UNIT FRONT PANEL IS NOT USED. PANEL MUST BE $\frac{1}{16}$ THICK.

NOTE:
1. ACCESSORY KIT NO. 596 1971 004 WILL CONVERT SW. TO EDGE LIGHTED PANEL MOUNTING.
2. ACCESSORY KITS FOR: VOLUME CONTROL 596 3258 002 OR VOLUME & SQUELCH CONTROLS 596 3259 002 TO BE SUPPLIED AS OPTIONAL.

Figure 12-36. Type 314U-10 Frequency Control Unit, Outline Drawing


.1875 $^{+.004}_{-.000}$ DIA.
PRESS IN PEM
FASTENER NO.
CL 632-2 FROM
REAR SIDE.
3/16 R
2 15/16
3 1/2
2 3/16
5/32
1 7/8
9/32
2 1/4
SCR NO. 6-32 NC 2X 3/16
FLAT HEAD
3 9/16
1
8
4
VHF TRANS RFC
COLLINS
5 7/16
4 7/16
3 1/16
INST. PANEL
RESISTOR WIRE WOUND
LINEAR TAPER
3000 OHMS
.037 AMPS.
1 1/2
3/4
.438
.406 DIA.- 2 HOLES
.219
.725
.055R
2 PLACES
.640
R
1.219
1 15/32
.156 DIA-3 HOLES
EQUALLY SPACED
ON A 1.625 DIA. B.C.
7/16 DIA.
2.438
.203
.406
.109 DIA.- 2 HOLES

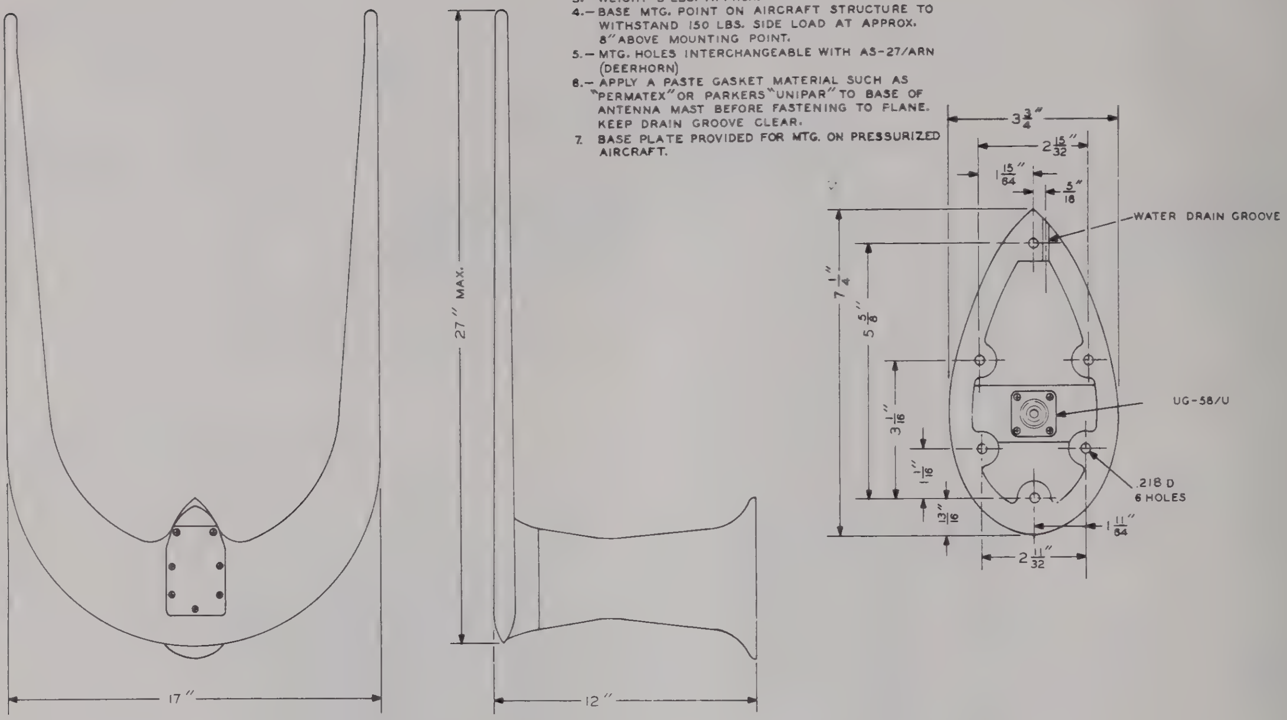
THIS HOLE PATTERN TO BE FOLLOWED WHEN UNIT FRONT PANEL IS USED AS SHOWN. PANEL MUST BE 1/16 THICK. FOR 1/8 PANEL, .1875 DIA. HOLES MUST BE C'BORED .375 DIA. BY .065 DEEP ON REVERSE SIDE.

THIS PATTERN IS FOLLOWED WHEN UNIT FRONT PANEL IS NOT USED. PANEL MUST BE 1/16 THICK

NOTE:

1. ACCESSORY KIT NO. 596 1971 004 WILL CONVERT SW TO EDGE LIGHTED PANEL MOUNTING.
2. ACCESSORY KIT FOR VOLUME CONTROL 596 3313 002 OR VOLUME AND SQUELCH CONTROL 596 3312 002 BE SUPPLIED AS OPTIONAL.

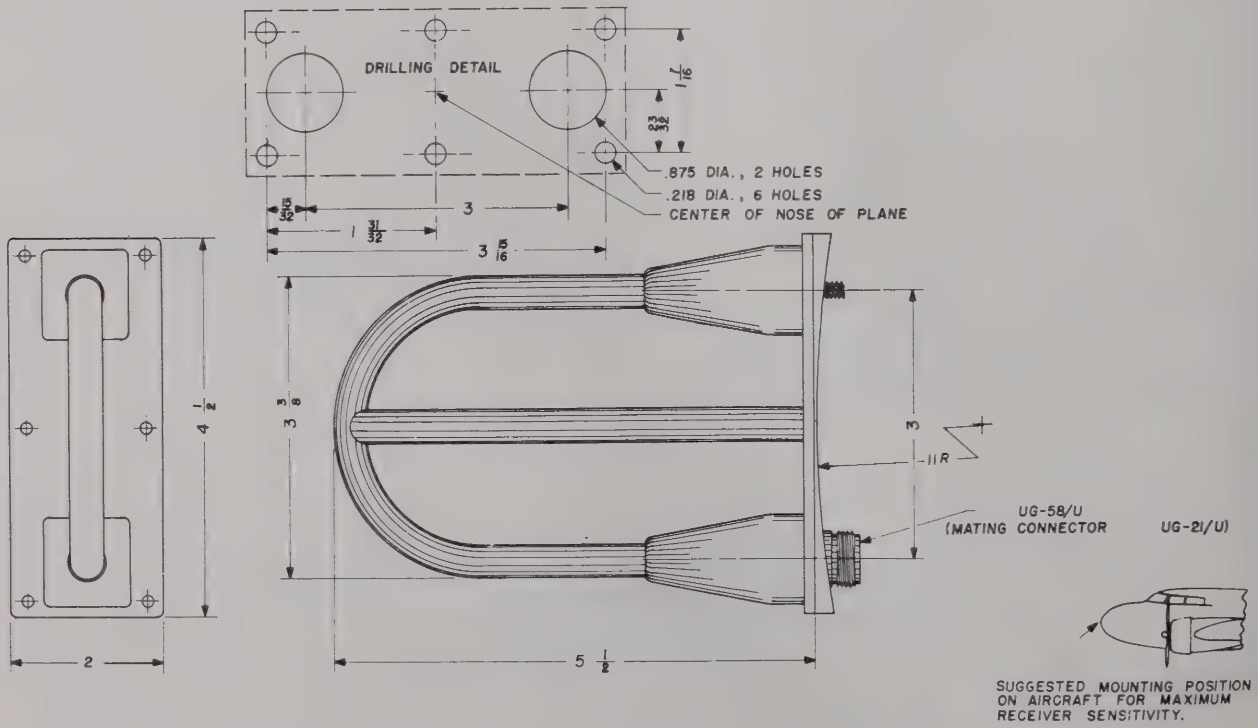
Figure 12-37. Type 614F-2 Frequency Control Unit, Outline Drawing


NOTES:

1. – BAND WIDTH 108-122 MC AT 5/1 SWR OR BETTER: TO FEED 52 OHM LINE.
2. – DRAG 2.7LBS. AT 250 MPH.
3. – WEIGHT 5 LBS. APPROX.
4. – BASE MTG. POINT ON AIRCRAFT STRUCTURE TO WITHSTAND 150 LBS. SIDE LOAD AT APPROX. 8" ABOVE MOUNTING POINT.
5. – MTG. HOLES INTERCHANGEABLE WITH AS-27/ARN (DEERHORN)
6. – APPLY A PASTE GASKET MATERIAL SUCH AS "PERMATEX" OR PARKERS "UNIPAR" TO BASE OF ANTENNA MAST BEFORE FASTENING TO PLANE. KEEP DRAIN GROOVE CLEAR.
7. BASE PLATE PROVIDED FOR MTG. ON PRESSURIZED AIRCRAFT.

17"
27" MAX.
12"
3 3/4"
2 15/32"
1 15/64"
5/16"
WATER DRAIN GROOVE
7 1/4"
5 5/8"
3 1/16"
1 1/16"
13/16"
UG-58/U
.218 D
6 HOLES
1 11/64"
2 11/32"

Figure 12-38. Type 37J-2 Antenna, Outline Drawing


DRILLING DETAIL
1 7/16
23/32
.875 DIA., 2 HOLES
.218 DIA., 6 HOLES
CENTER OF NOSE OF PLANE
15/32
3
1 31/32
3 15/16
4 1/2
2
3 3/8
3
11R
UG-58/U
(MATING CONNECTOR UG-21/U)
5 1/2

SUGGESTED MOUNTING POSITION ON AIRCRAFT FOR MAXIMUM RECEIVER SENSITIVITY.

Figure 12-39. Type 37P-1 Glide Slope Antenna, Outline Drawing

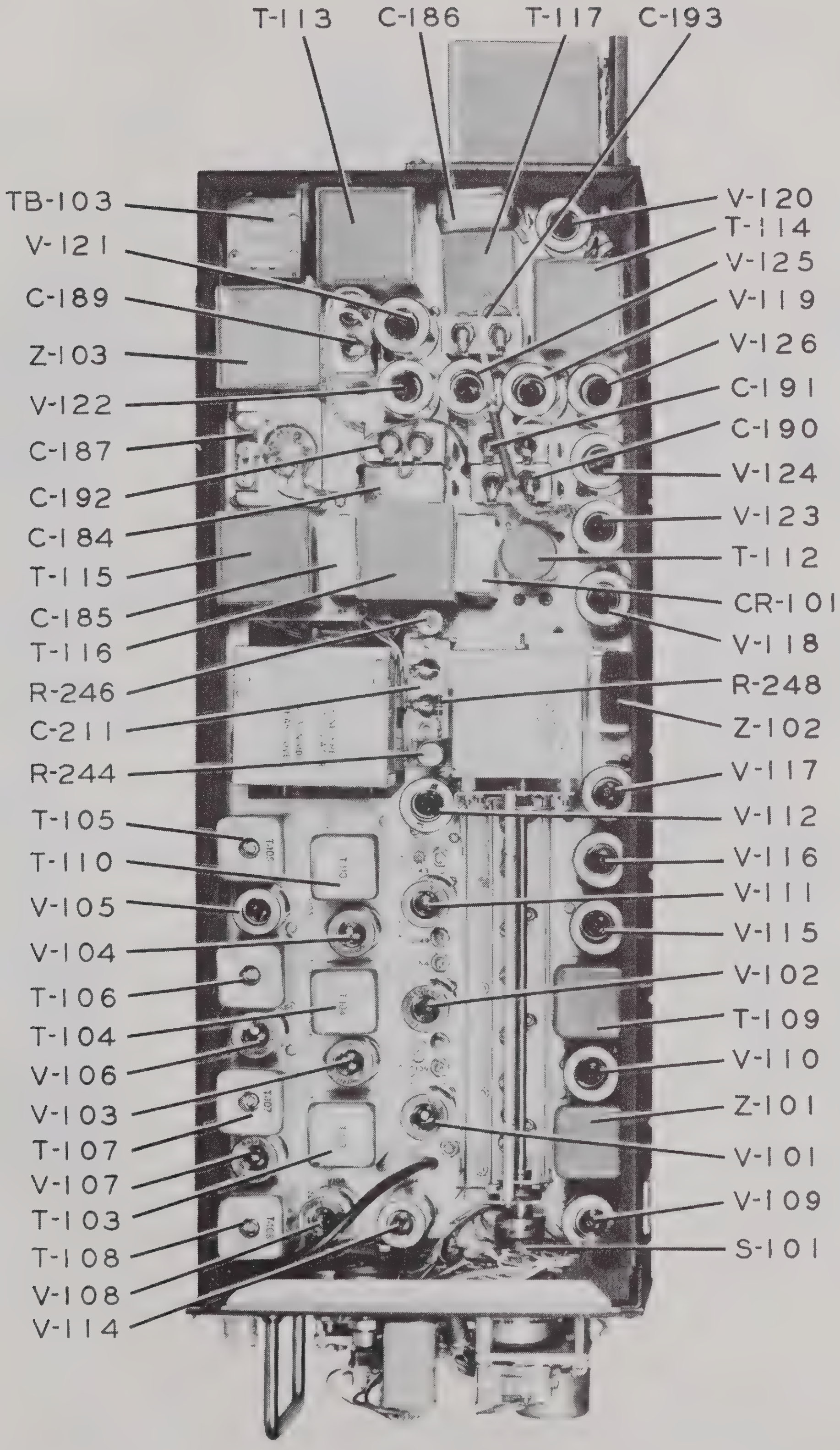

T-113
C-186
T-117
C-193
TB-103
V-121
C-189
Z-103
V-122
C-187
C-192
C-184
T-115
C-185
T-116
R-246
C-211
R-244
T-105
T-110
V-105
V-104
T-106
T-104
V-106
V-103
T-107
V-107
T-103
T-108
V-108
V-114
V-120
T-114
V-125
V-119
V-126
C-191
C-190
V-124
V-123
T-112
CR-101
V-118
R-248
Z-102
V-117
V-112
V-116
V-111
V-115
V-102
T-109
V-110
Z-101
V-101
V-109
S-101

Figure 12-40. Type 51R-3 Navigation Receiver, Tube Side

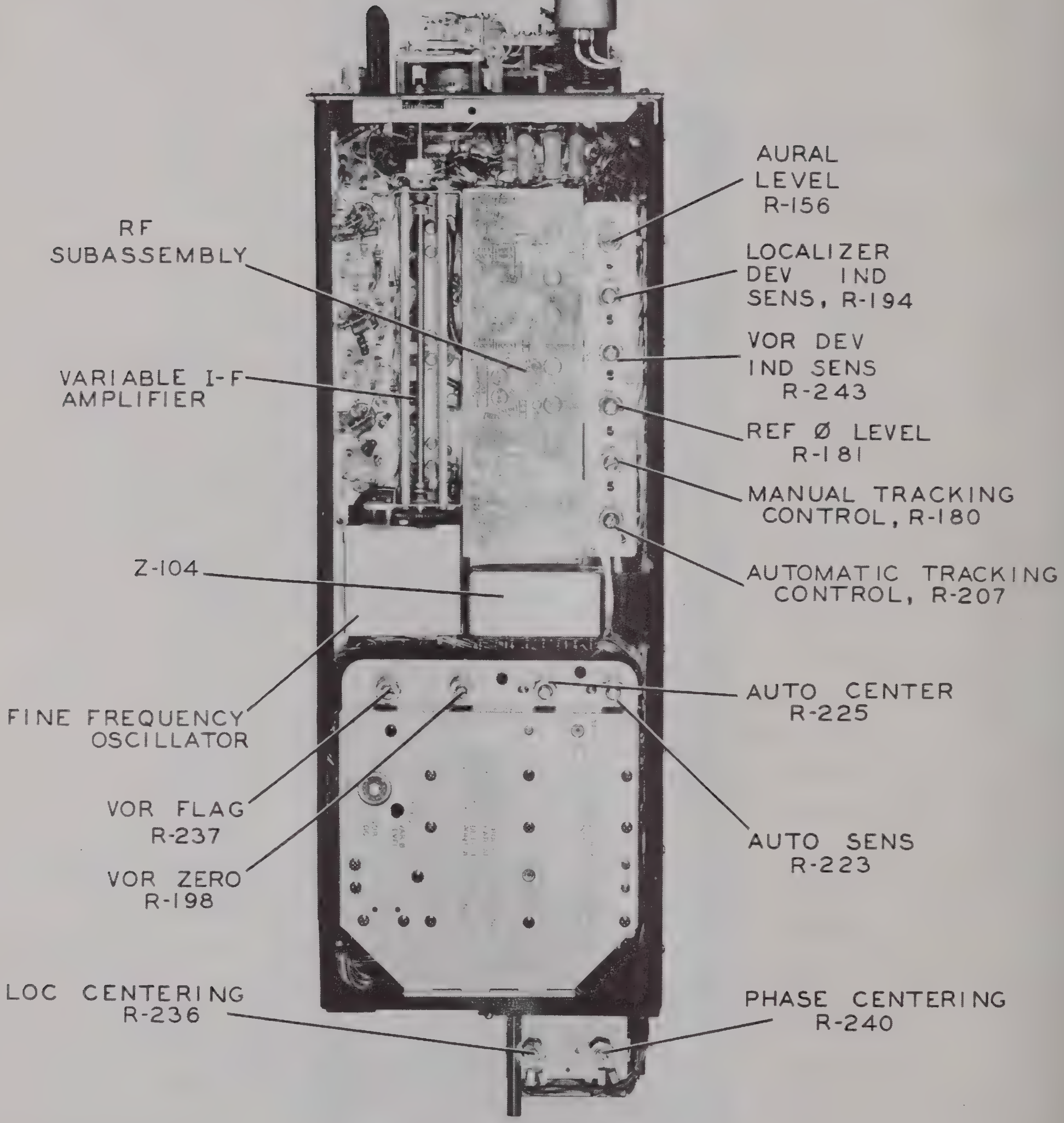
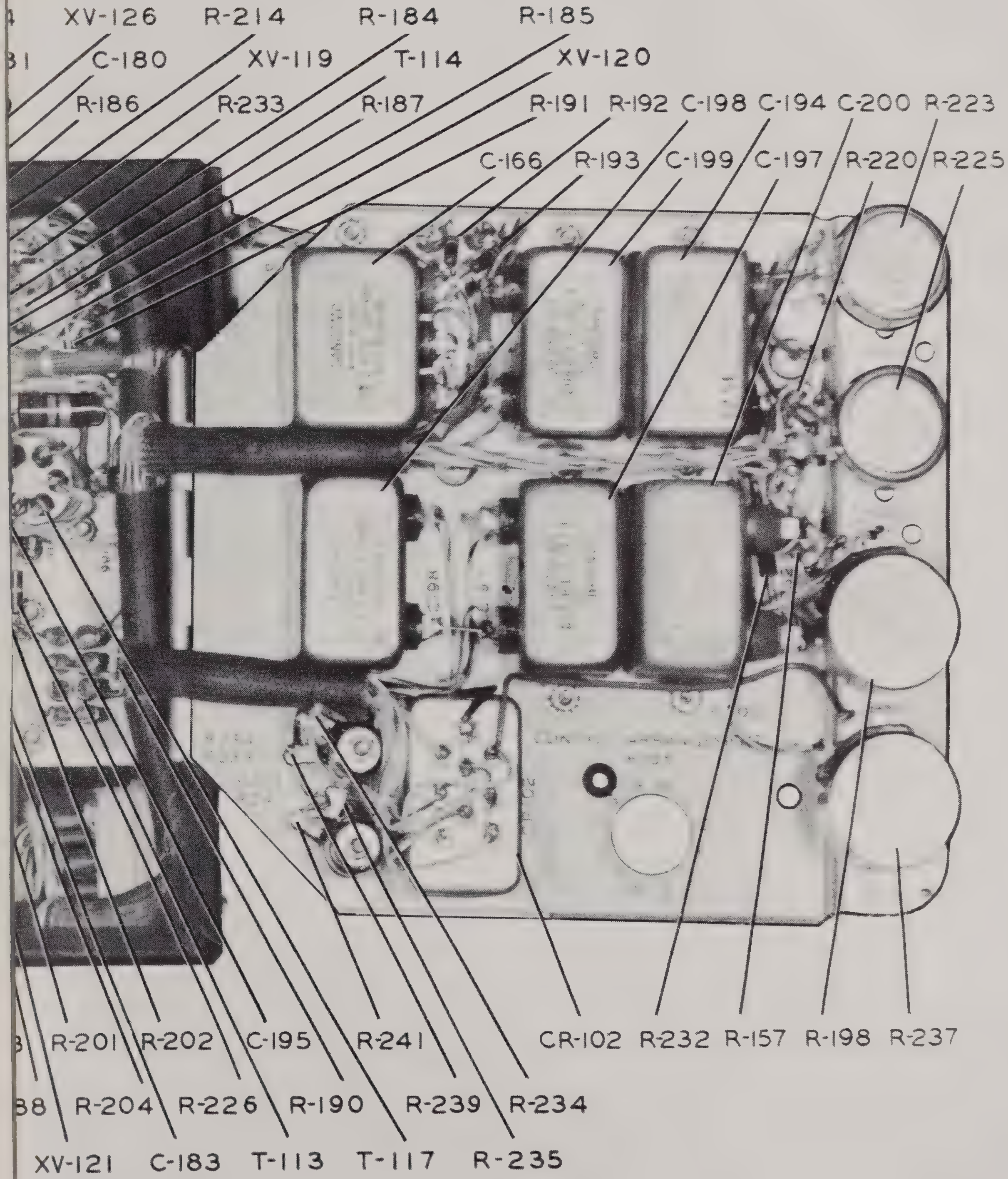

AURAL LEVEL R-156
RF SUBASSEMBLY
LOCALIZER DEV IND SENS, R-194
VOR DEV IND SENS R-243
VARIABLE I-F AMPLIFIER
REF Ø LEVEL R-181
MANUAL TRACKING CONTROL, R-180
Z-104
AUTOMATIC TRACKING CONTROL, R-207
AUTO CENTER R-225
FINE FREQUENCY OSCILLATOR
VOR FLAG R-237
AUTO SENS R-223
VOR ZERO R-198
LOC CENTERING R-236
PHASE CENTERING R-240

Figure 12-41. Type 51R-3 Navigation Receiver, Wiring Side


4
XV-126
R-214
R-184
R-185
31
C-180
XV-119
T-114
XV-120
R-186
R-233
R-187
R-191
R-192
C-198
C-194
C-200
R-223
C-166
R-193
C-199
C-197
R-220
R-225
3
R-201
R-202
C-195
R-241
CR-102
R-232
R-157
R-198
R-237
38
R-204
R-226
R-190
R-239
R-234
XV-121
C-183
T-113
T-117
R-235

ure 12-42. Type 51R-3 Navigation Receiver, Wiring Side, Covers and Panels Removed

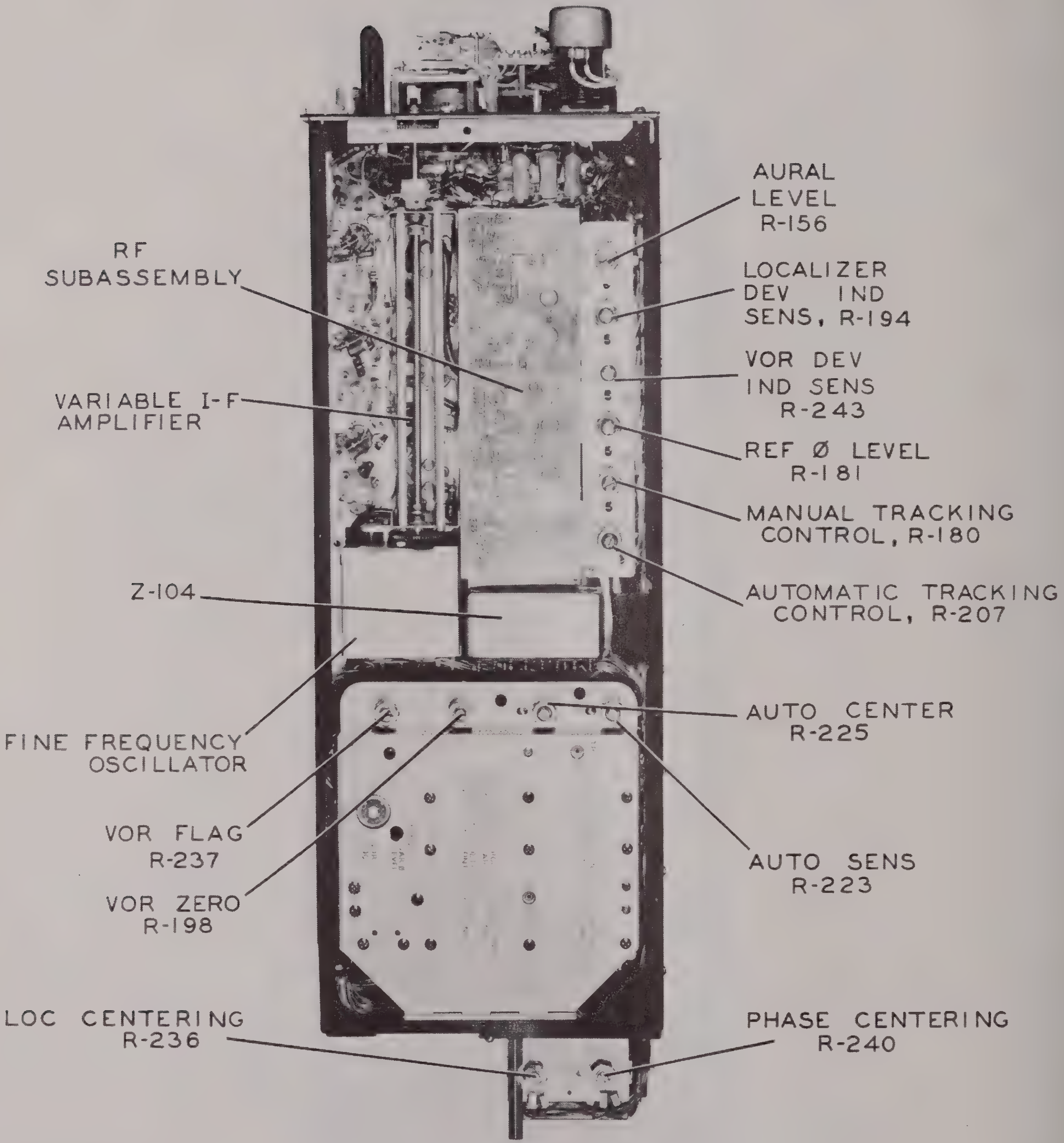

AURAL LEVEL R-156
RF SUBASSEMBLY
LOCALIZER DEV IND SENS, R-194
VOR DEV IND SENS R-243
VARIABLE I-F AMPLIFIER
REF Ø LEVEL R-181
MANUAL TRACKING CONTROL, R-180
Z-104
AUTOMATIC TRACKING CONTROL, R-207
AUTO CENTER R-225
FINE FREQUENCY OSCILLATOR
VOR FLAG R-237
AUTO SENS R-223
VOR ZERO R-198
LOC CENTERING R-236
PHASE CENTERING R-240

Figure 12-41. Type 51R-3 Navigation Receiver, Wiring Side

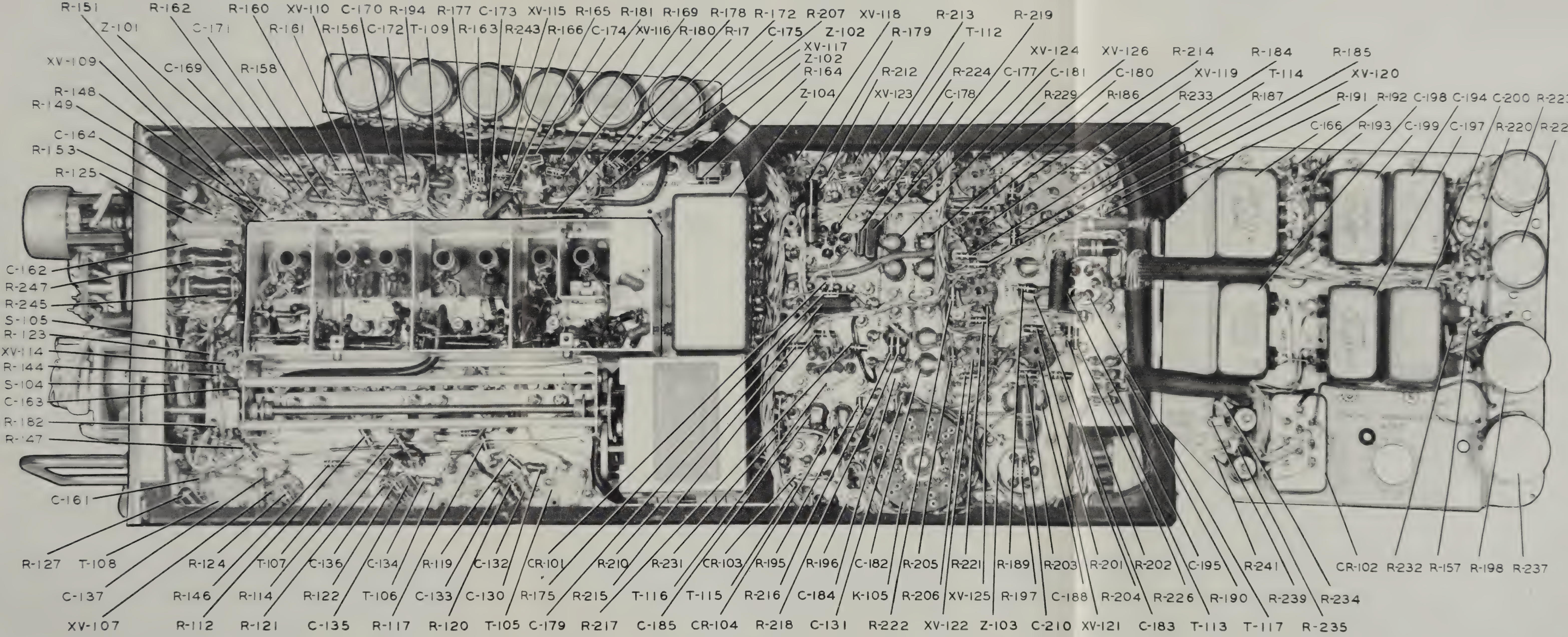

R-151
R-162
R-160
XV-110
C-170
R-194
R-177
C-173
XV-115
R-165
R-181
R-169
R-178
R-172
R-207
XV-118
R-213
R-219
Z-101
C-171
R-161
R-156
C-172
T-109
R-163
R-243
R-166
C-174
XV-116
R-180
R-17
C-175
Z-102
R-179
T-112
XV-117
Z-102
R-164
Z-104
XV-124
XV-126
R-214
R-184
R-185
XV-109
C-169
R-158
R-212
R-224
C-177
C-181
C-180
XV-119
T-114
XV-120
R-148
R-149
XV-123
C-178
R-229
R-186
R-233
R-187
R-191
R-192
C-198
C-194
C-200
R-223
C-164
R-153
R-125
C-166
R-193
C-199
C-197
R-220
R-225
C-162
R-247
R-245
S-105
R-123
XV-114
R-144
S-104
C-163
R-182
R-147
C-161
R-127
T-108
R-124
T-107
C-136
C-134
R-119
C-132
CR-101
R-210
R-231
CR-103
R-195
R-196
C-182
R-205
R-221
R-189
R-203
R-201
R-202
C-195
R-241
CR-102
R-232
R-157
R-198
R-237
C-137
R-146
R-114
R-122
T-106
C-133
C-130
R-175
R-215
T-116
T-115
R-216
C-184
K-105
R-206
XV-125
R-197
C-188
R-204
R-226
R-190
R-239
R-234
XV-107
R-112
R-121
C-135
R-117
R-120
T-105
C-179
R-217
C-185
CR-104
R-218
C-131
R-222
XV-122
Z-103
C-210
XV-121
C-183
T-113
T-117
R-235

Figure 12-42. Type 51R-3 Navigation Receiver, Wiring Side, Covers and Panels Removed

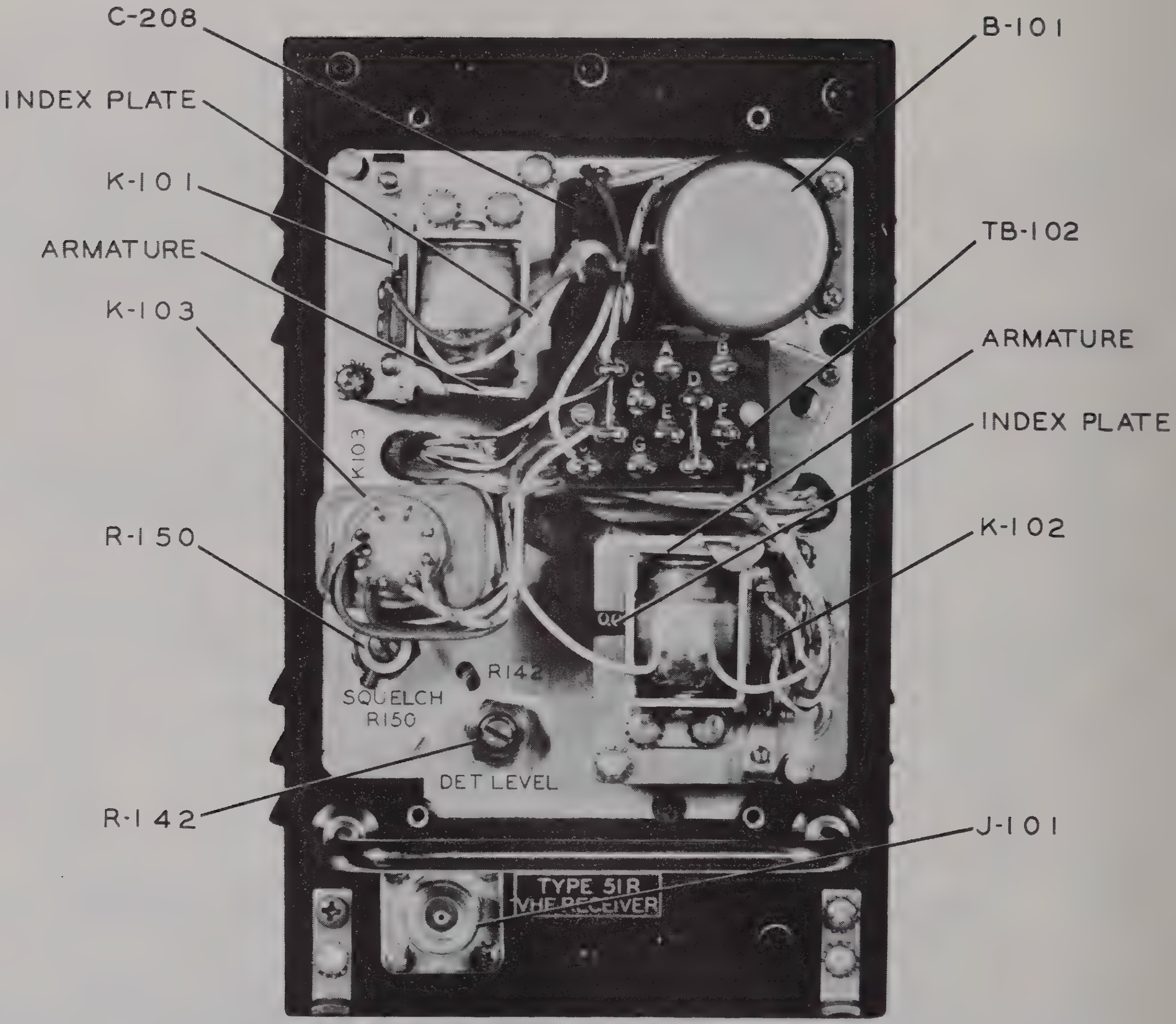

C-208
INDEX PLATE
K-101
ARMATURE
K-103
R-150
R-142
B-101
TB-102
ARMATURE
INDEX PLATE
K-102
J-101
K103
A
B
C
D
E
F
G
R142
SQUELCH
R150
DET LEVEL
TYPE 51R
VHF RECEIVER

Figure 12-43. Type 51R-3 Navigation Receiver, Front View

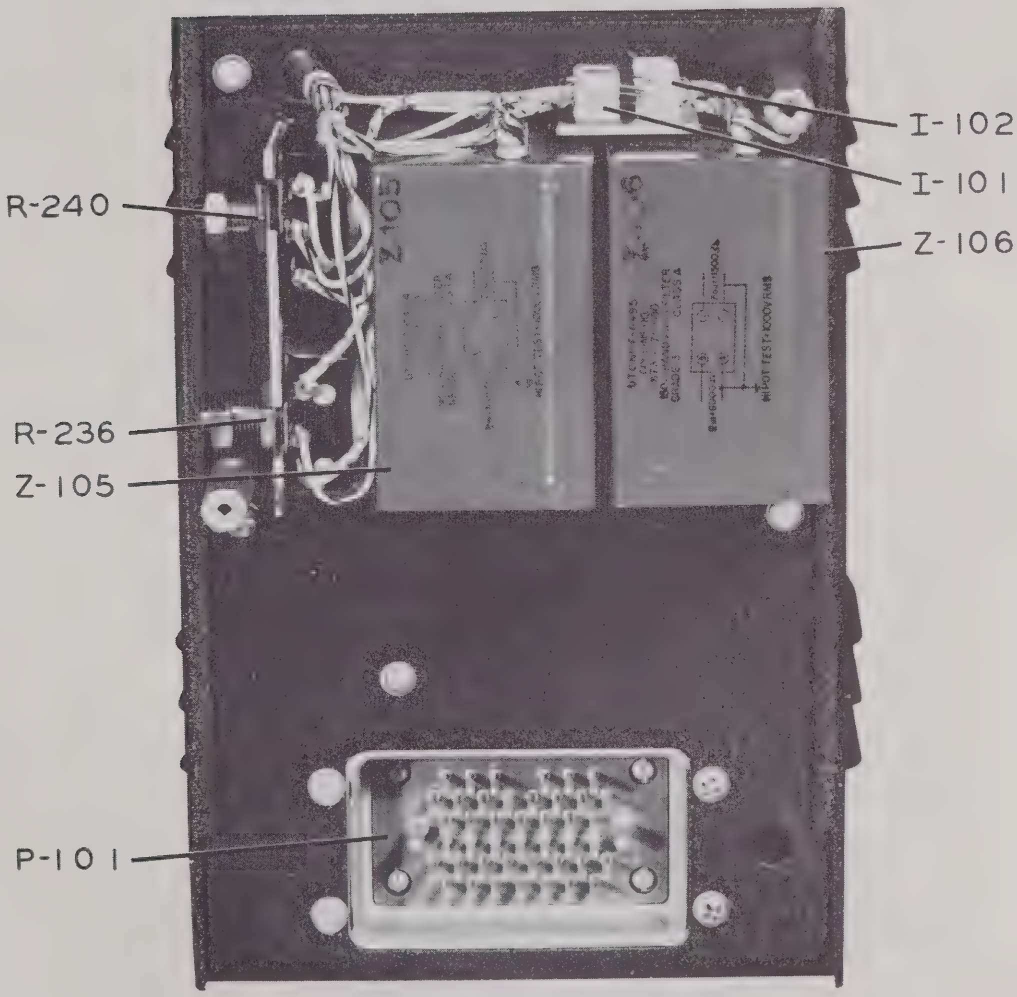

I-102
I-101
Z-106
R-240
R-236
Z-105
P-101

Figure 12-44. Type 51R-3 Navigation Receiver, Rear View

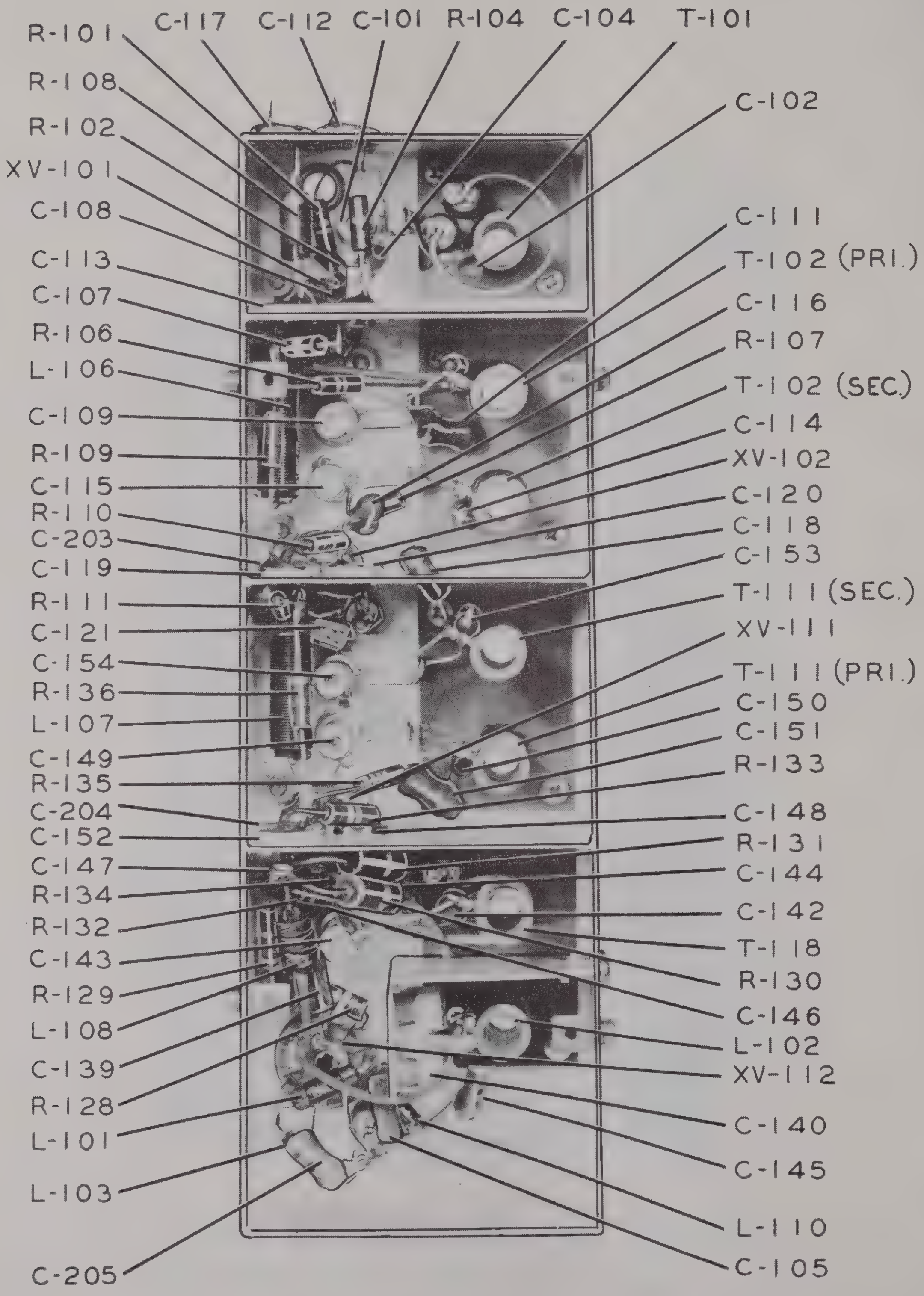

R-101
C-117
C-112
C-101
R-104
C-104
T-101
R-108
R-102
XV-101
C-108
C-113
C-107
R-106
L-106
C-109
R-109
C-115
R-110
C-203
C-119
R-111
C-121
C-154
R-136
L-107
C-149
R-135
C-204
C-152
C-147
R-134
R-132
C-143
R-129
L-108
C-139
R-128
L-101
L-103
C-205
C-102
C-111
T-102 (PRI.)
C-116
R-107
T-102 (SEC.)
C-114
XV-102
C-120
C-118
C-153
T-111 (SEC.)
XV-111
T-111 (PRI.)
C-150
C-151
R-133
C-148
R-131
C-144
C-142
T-118
R-130
C-146
L-102
XV-112
C-140
C-145
L-110
C-105

Figure 12-45. Type 51R-3 Navigation Receiver, R-F Subassembly

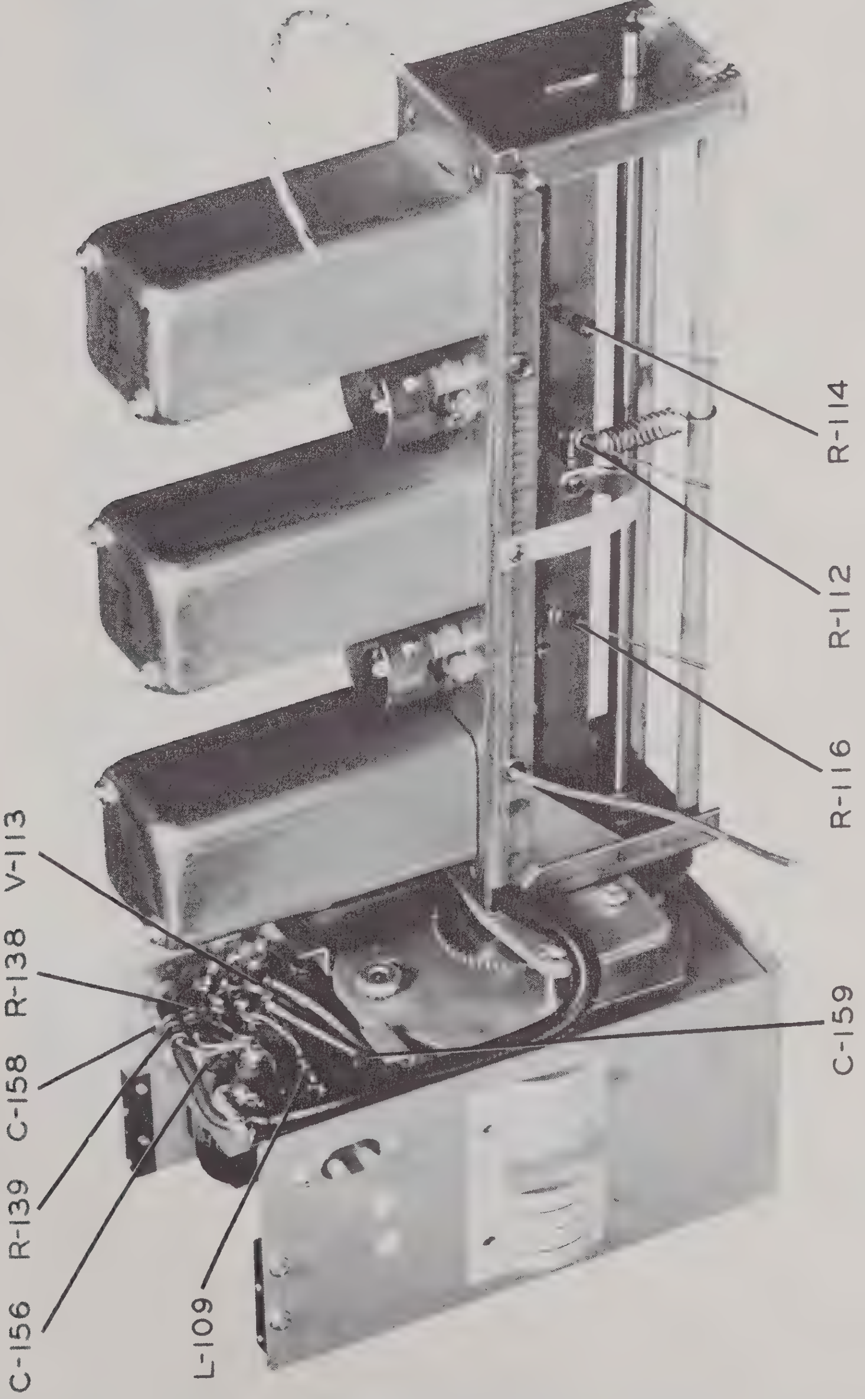

R-114
R-112
R-116
C-159
V-113
R-138
C-158
R-139
C-156
L-109

Figure 12-46. Type 51R-3 Navigation Receiver, Variable I-F Amplifier and Fine Frequency Oscillator Subassembly, Top View

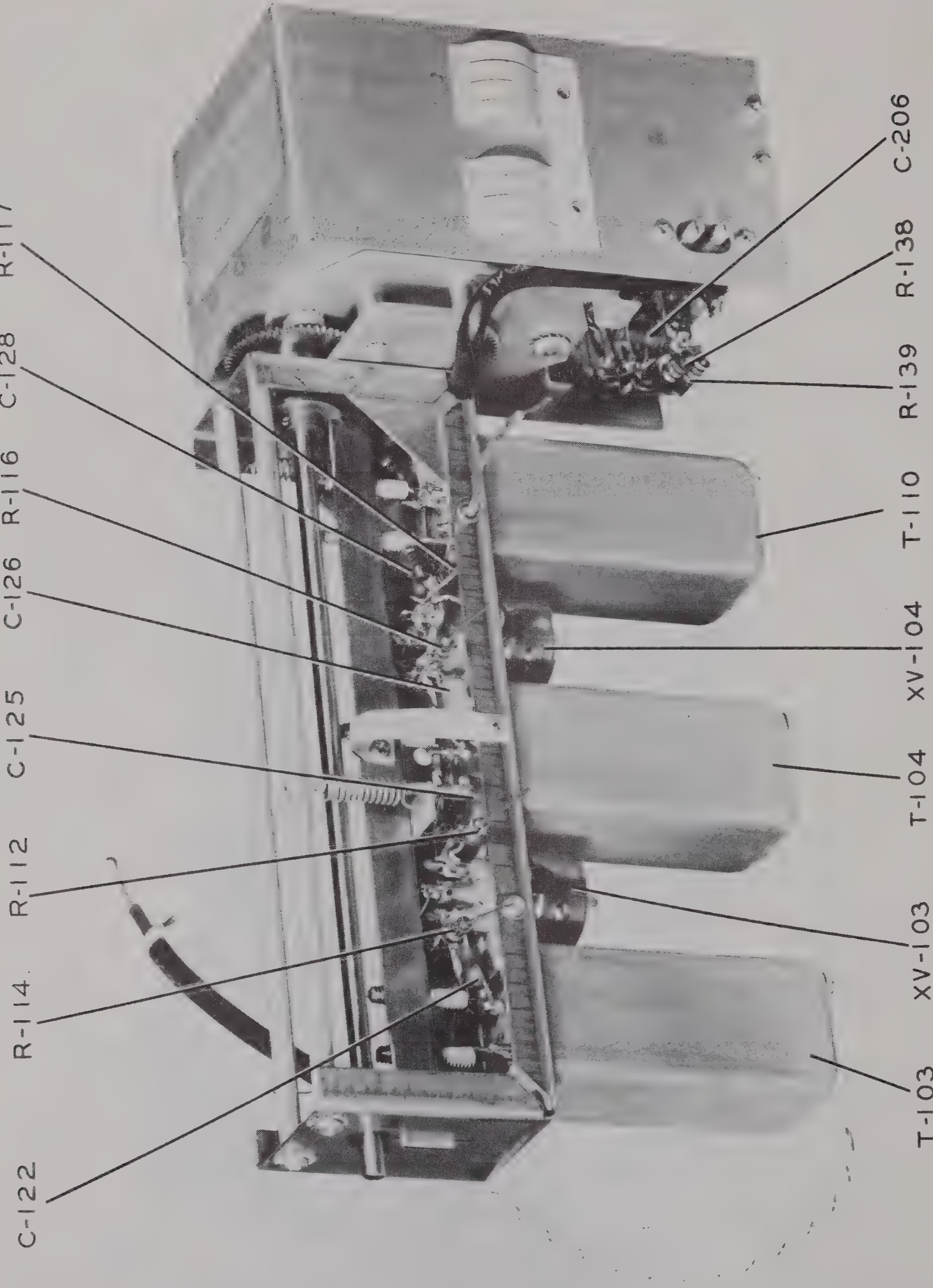

R-117
C-128
R-116
C-126
C-125
R-112
R-114
C-122
C-206
R-138
R-139
T-110
XV-104
T-104
XV-103
T-103

Figure 12-47. Type 51R-3 Navigation Receiver, Variable I-F Amplifier and Fine Frequency Oscillator, Bottom View

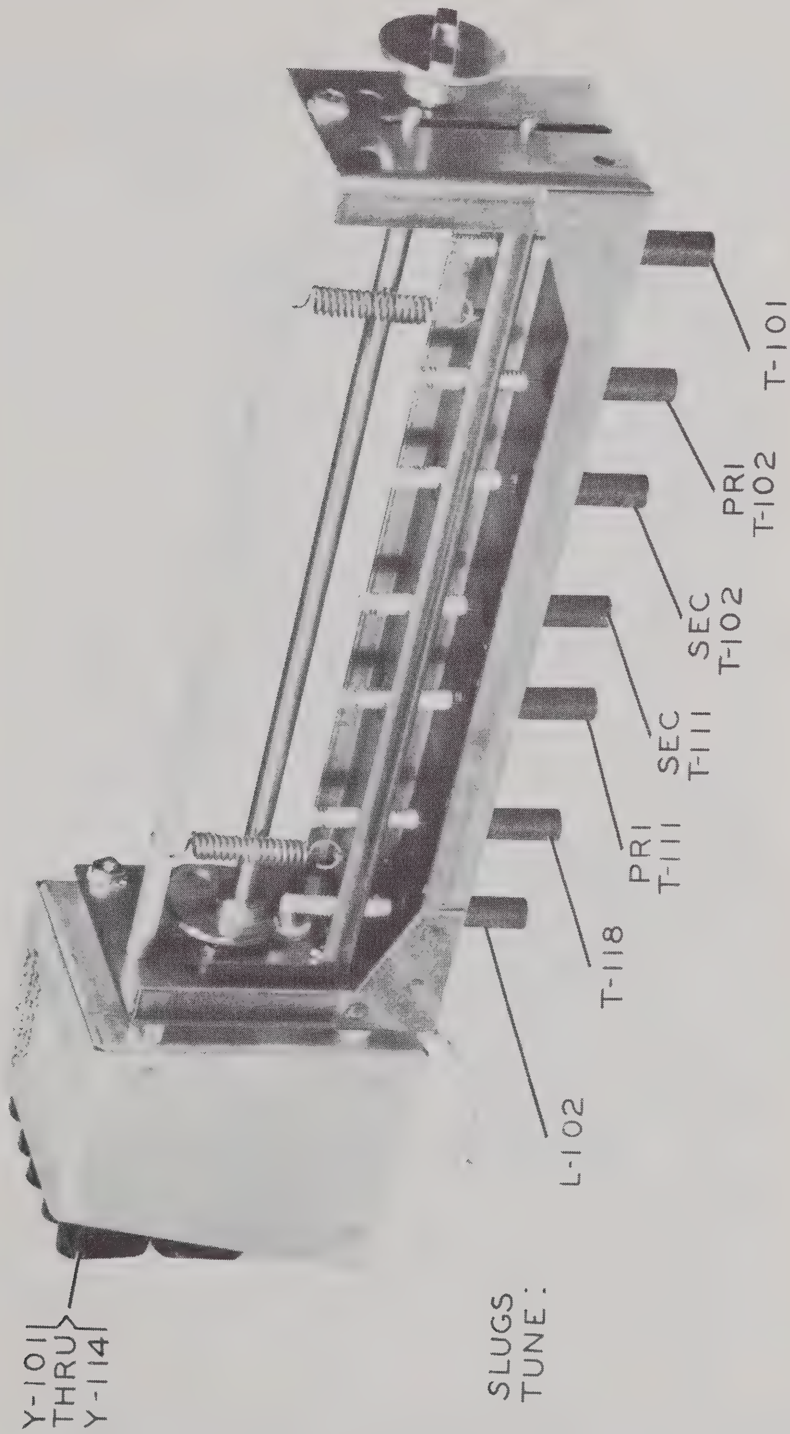

T-101
PRI T-102
SEC T-102
SEC T-111
PRI T-111
T-118
L-102
Y-101 THRU Y-114
SLUGS TUNE:

Figure 12-48. Type 51R-3 Navigation Receiver, Coarse Frequency Oscillator

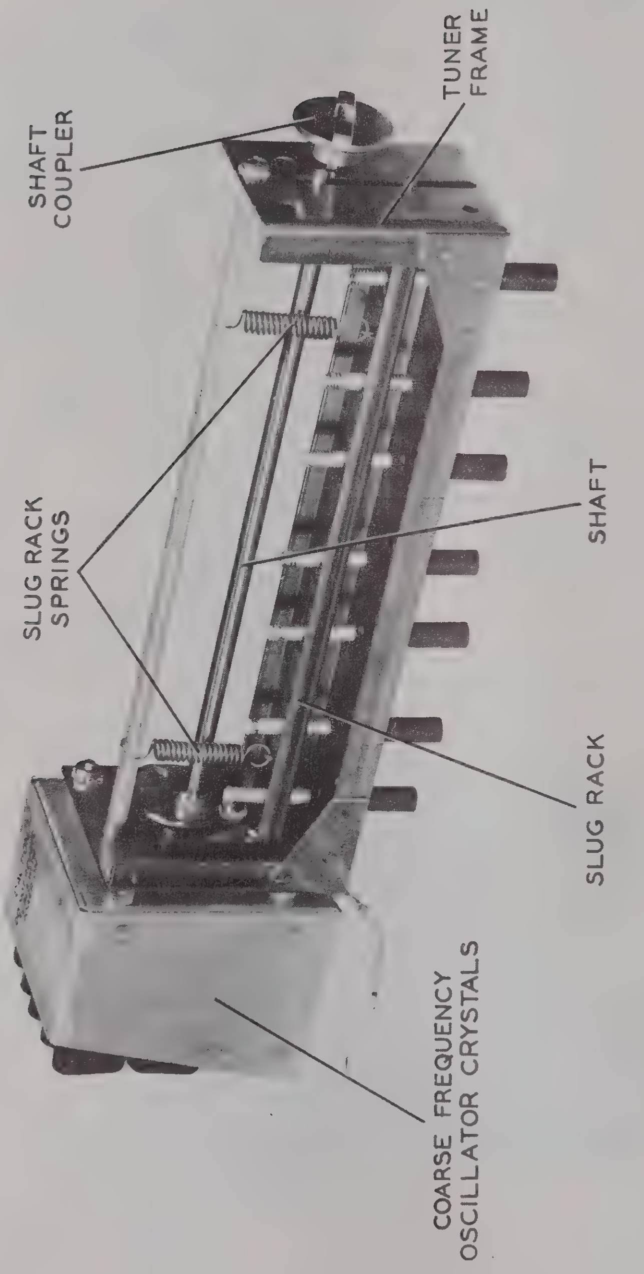

SHAFT COUPLER
TUNER FRAME
SLUG RACK SPRINGS
SHAFT
SLUG RACK
COARSE FREQUENCY OSCILLATOR CRYSTALS

Figure 12-49. Type 51R-3 Navigation Receiver, Coarse Frequency Tuner

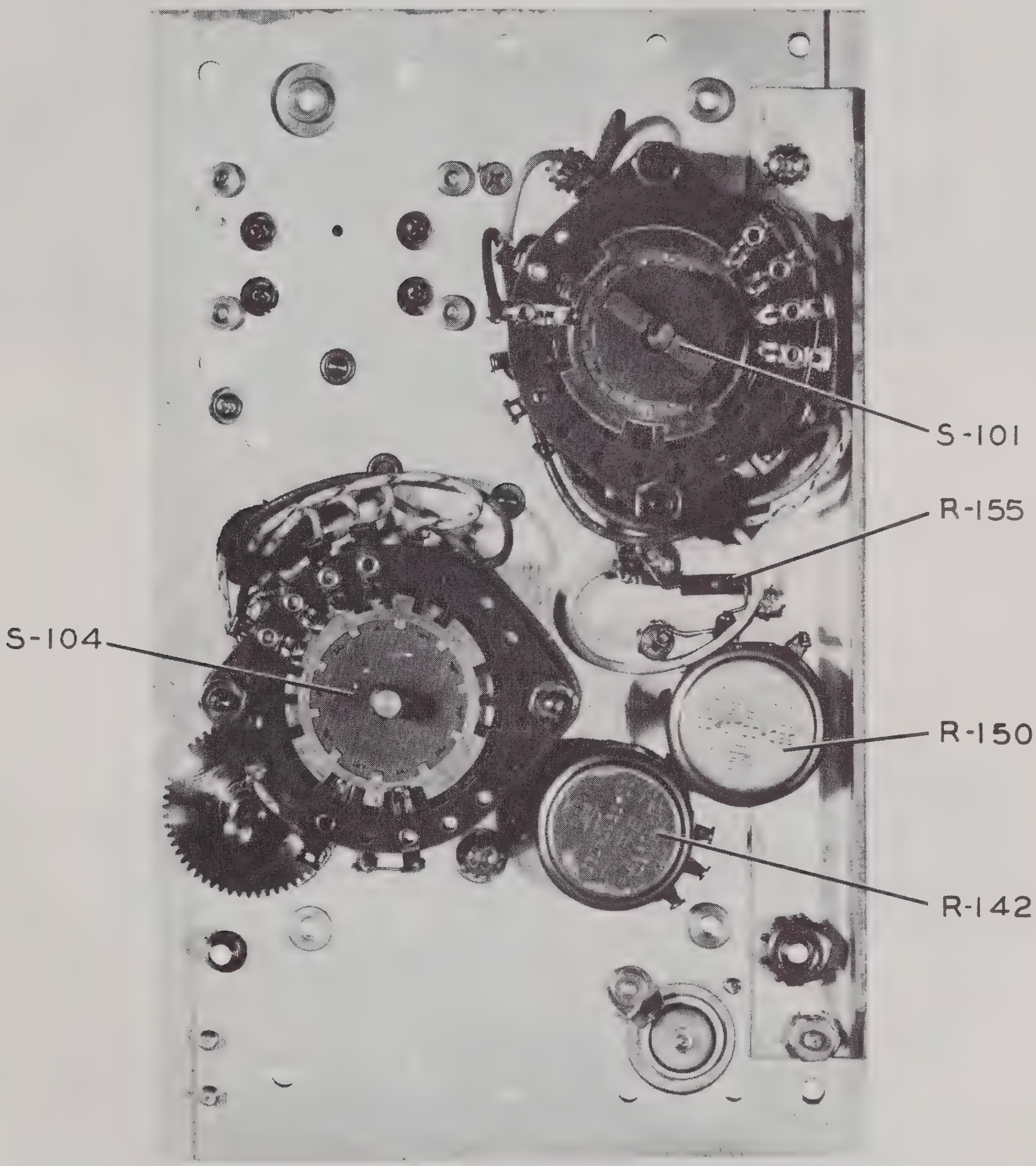

S-101
R-155
S-104
R-150
R-142

Figure 12-50. Type 51R-3 Navigation Receiver, Rear of Front Panel

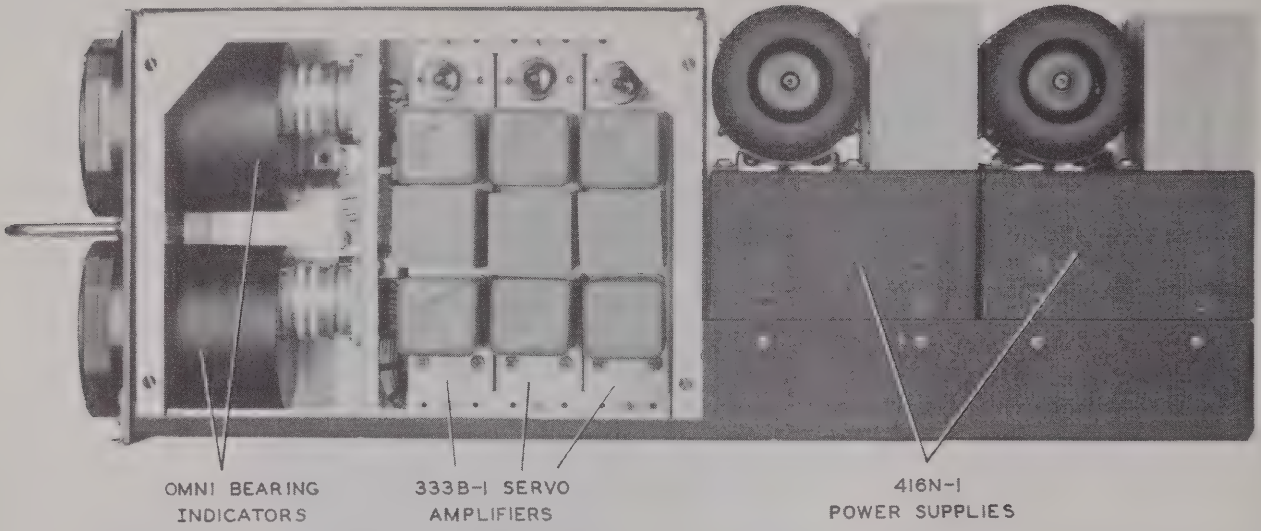

OMNI BEARING INDICATORS
333B-1 SERVO AMPLIFIERS
416N-1 POWER SUPPLIES

Figure 12-51. Type 351A-1 Accessory Frame, Side View

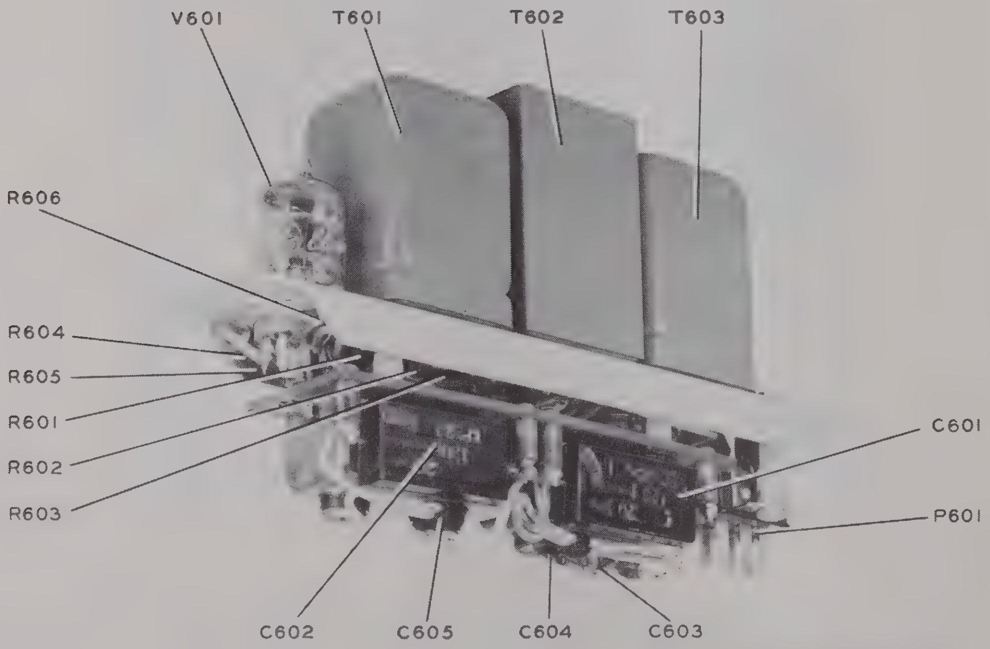

V601
T601
T602
T603
R606
R604
R605
R601
R602
R603
C601
P601
C602
C605
C604
C603

Figure 12-52. Type 333B-1 Servo Amplifier, Side View

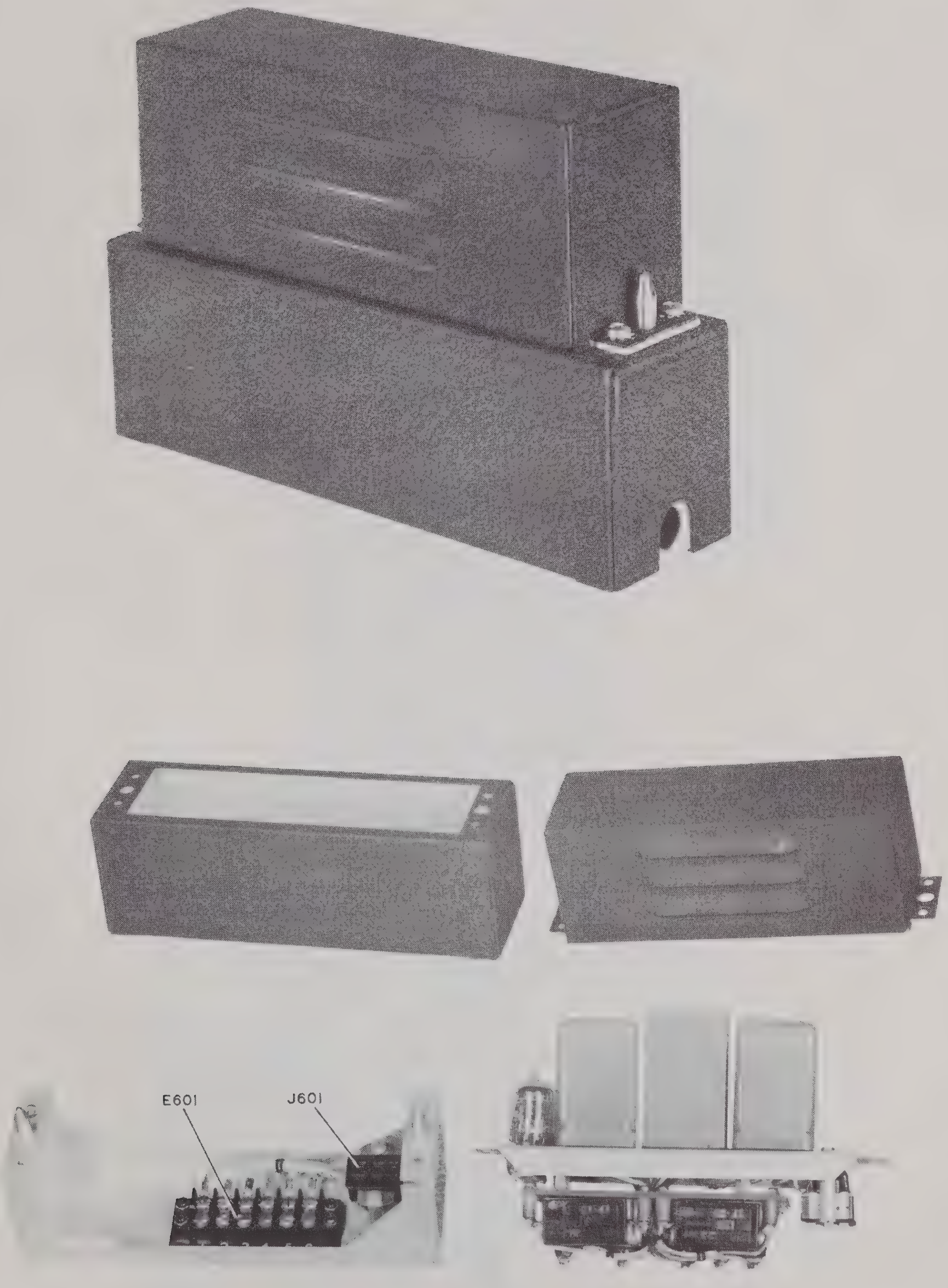

E601
J601
THIS AMPLIFIER SAME AS
333B-1

Figure 12-53. Type 333B-3 Servo Amplifier, Disassembled

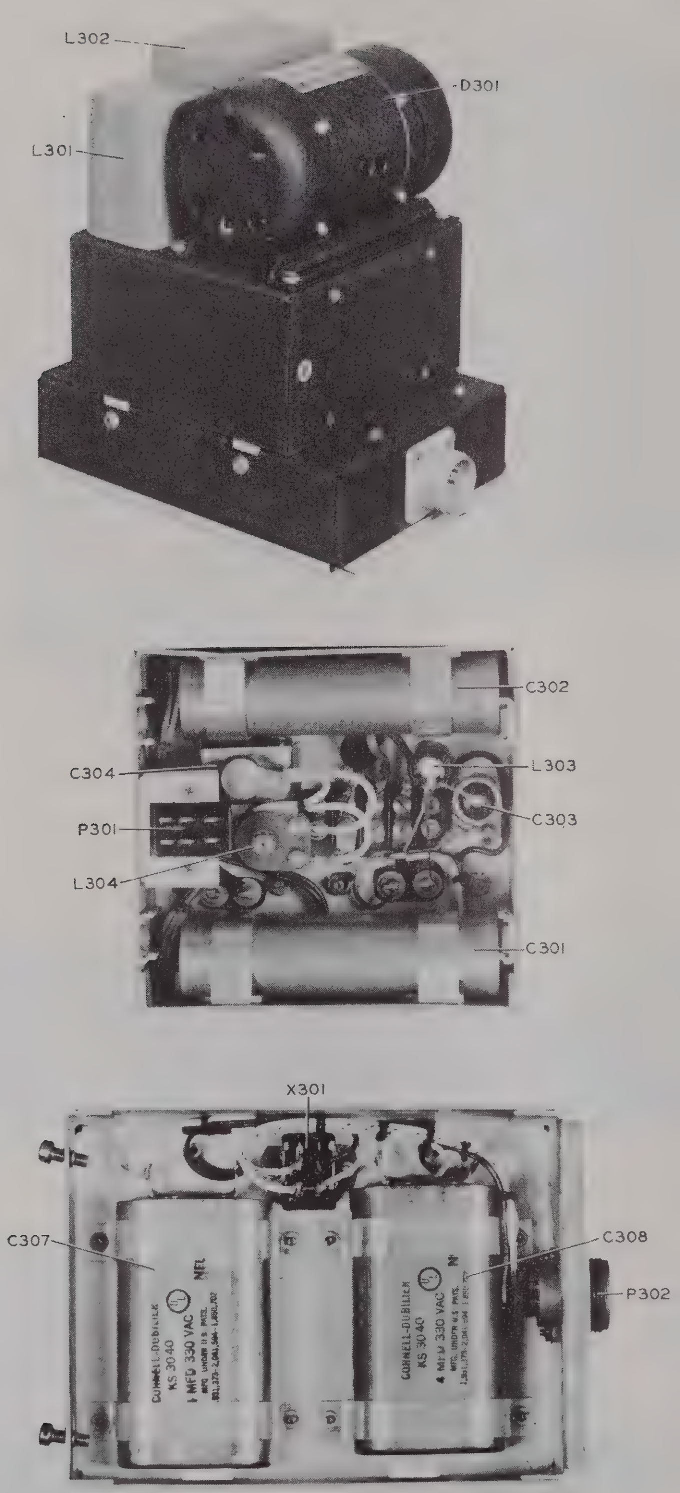

L302
D301
L301
C302
C304
L303
P301
C303
L304
C301
X301
C307
C308
P302
CORNELL-DUBILIER
KS 3040
1 MFD 330 VAC
CORNELL-DUBILIER
KS 3040
4 MFD 330 VAC

Figure 12-54. Type 416N-1 Power Supply, Side and Bottom Views

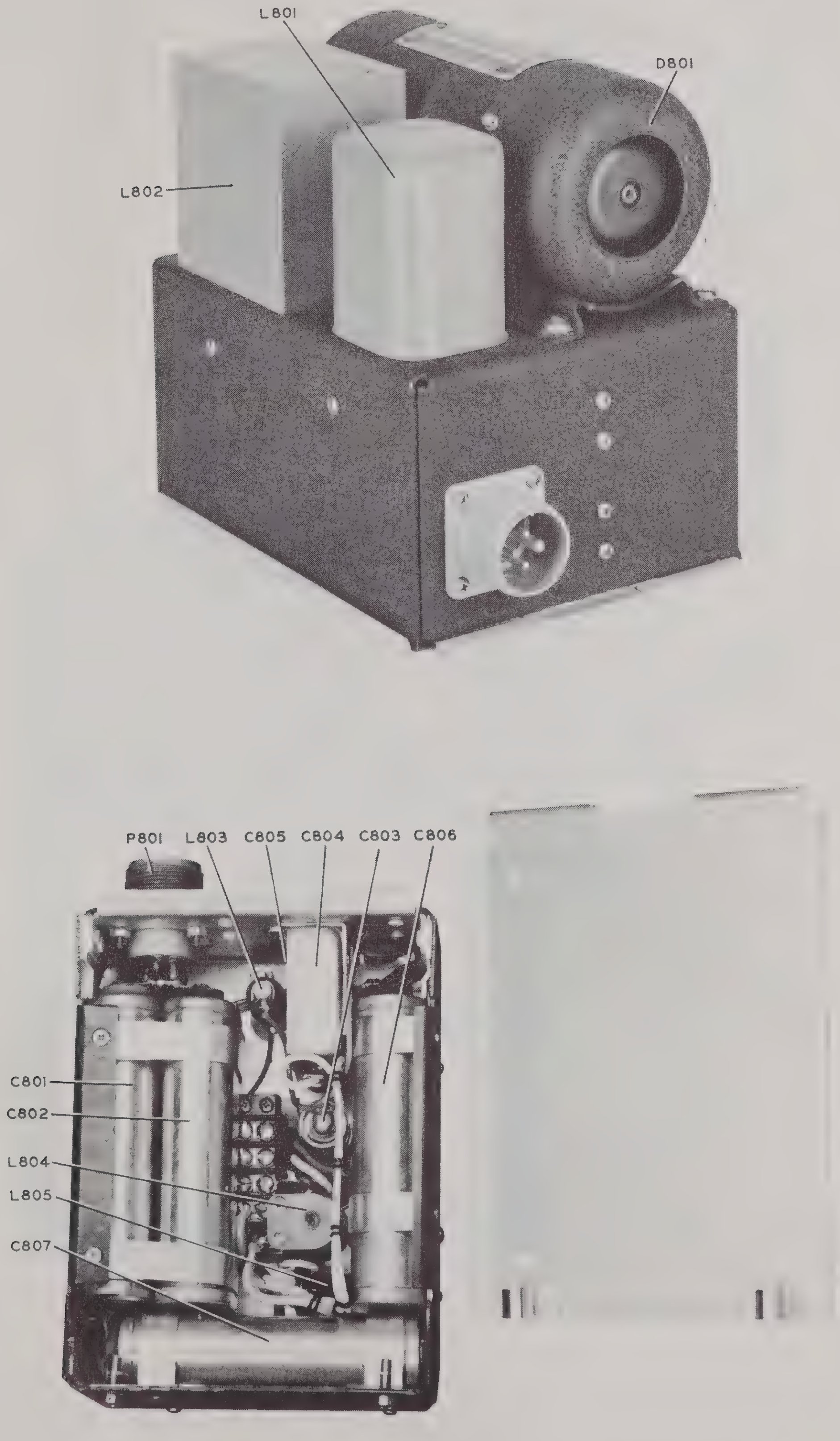
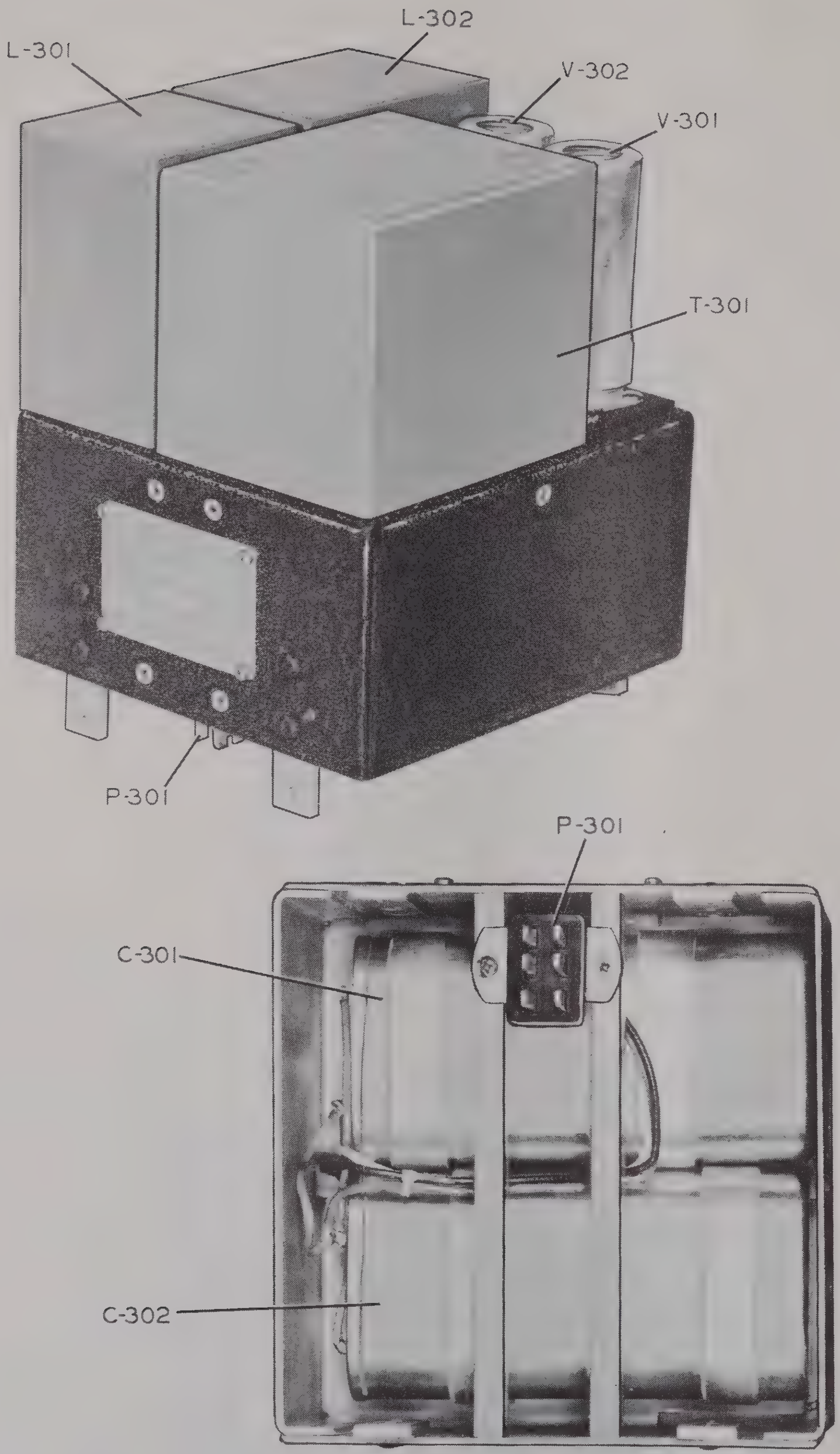

L801
D801
L802
P801
L803
C805
C804
C803
C806
C801
C802
L804
L805
C807

Figure 12-55. Type 416N-2 Power Supply, Side and Bottom Views


L-302
L-301
V-302
V-301
T-301
P-301
P-301
C-301
C-302

BOTTOM VIEW

Figure 12-56. Type 416N-5 Power Supply, Side and Bottom Views

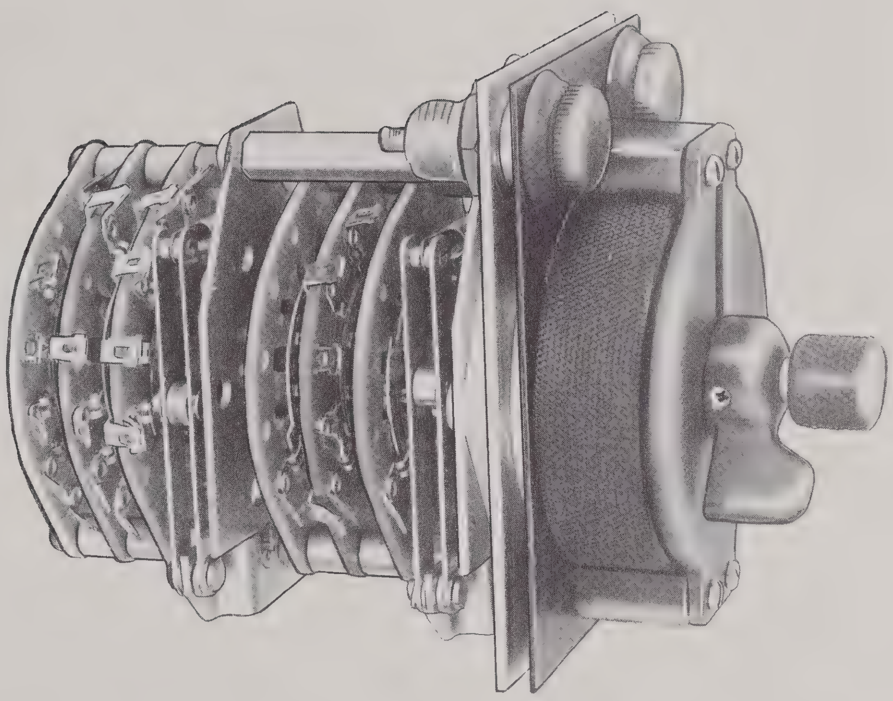


Figure 12-57. Type 314U-8 Control Unit, Side View

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

DALLAS NEW YORK WASHINGTON BURBANK
OTTAWA RIO DE JANEIRO TORONTO LONDON